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IN THE

Supreme Court of the United States

OCTOBER TERM, 1983

STRUTHERS PATENT CORPORATION,
STRUTHERS WELLS CORPORATION and
STRUTHERS SCIENTIFIC & INTERNATIONAL CORPORATION,
Petitioners,

–against–

THE NESTLE COMPANY, INC.,
Respondent.

PATENT APPENDIX TO PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE THIRD CIRCUIT
Appendix Pages A-684 – A-723

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Feb. 6, 1968 J. D. HOWELL 3,367,126

FLOATING AGITATOR

Filed May 19, 1966

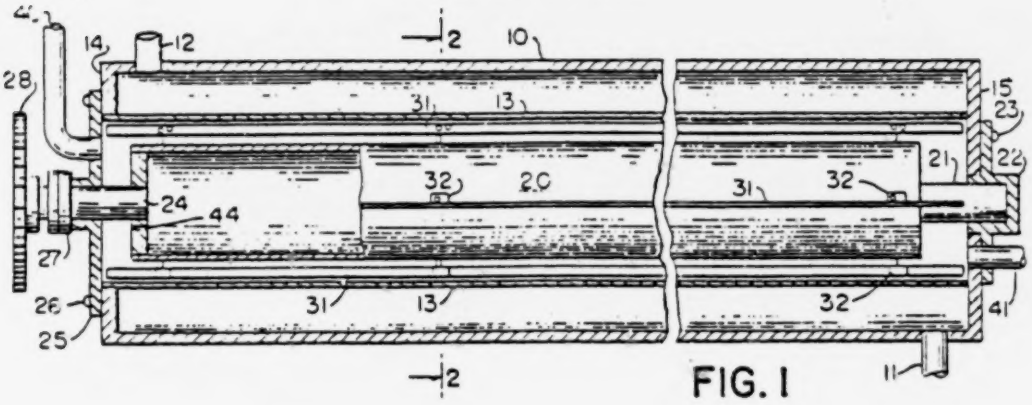

FIG. 1

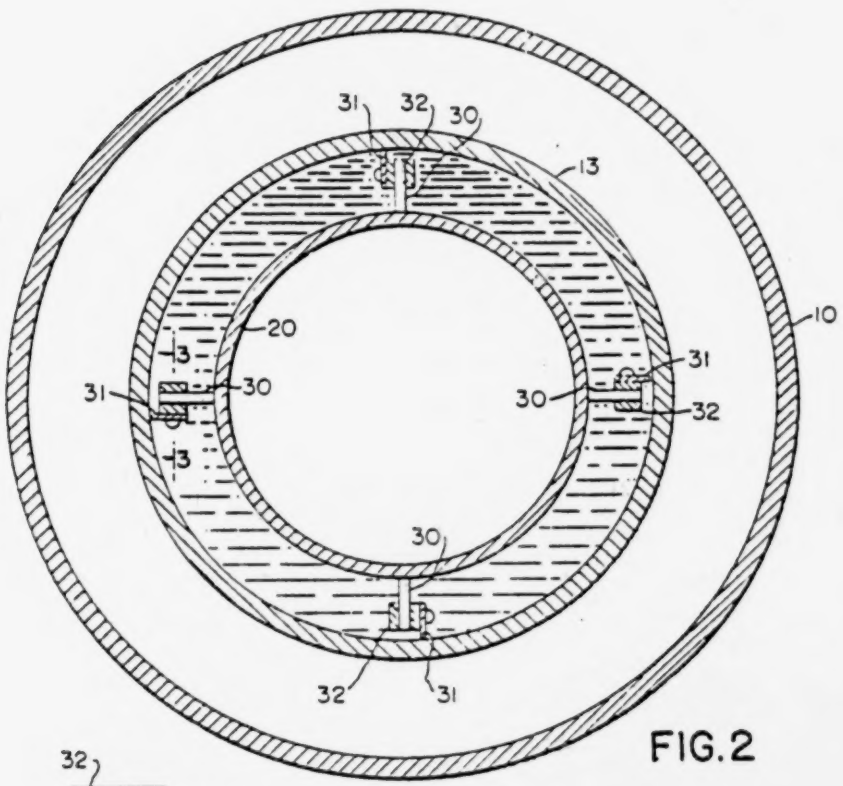

FIG. 2

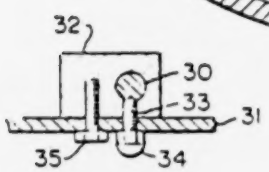

FIG. 3

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United States Patent Office 3,367,126 Patented Feb. 6, 1968

3,367,126

FLOATING AGITATOR

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Filed May 19, 1966, Ser. No. 551,252
3 Claims. (Cl. 62—123)

ABSTRACT OF THE DISCLOSURE

A tubular crystallizer for solutions having an agitator shaft, an agitator means and a mounting means which are substantially the same weight per unit of length as the weight of solution displaced by them.

This invention relates in general to freeze concentration, and, more particularly, to tubular crystallizers.

A tubular crystallizer has one or more elongated tubes passing through a tank of refrigerant. A solution to have crystals formed in it is passed through the tube so that crystals may form within the crystallizer tube as heat is transferred therethrough. To prevent crystal buildup on the tube walls, an agitator shaft extends through the crystallizer tube and has longitudinal blades mounted thereon to extend with slight clearance toward the walls of the tube. Oscillatory or rotary motion of the agitator shaft and its blades prevents crystals from forming on the crystallizer tube wall or removes them from the wall to promote uniform crystal growth.

For efficient and greater capacity operation of such crystallizers, the length of the crystallizer tube is an important factor. Heretofore, tube lengths over ten feet were costly and difficult to build, as high bending moments were present in long agitator shafts with the result that shaft alignment in the tubes was difficult. Stiffening of the agitator shafts rendered them heavy and costly. In some applications, bearing shoes to slide on the inner side of the tube walls were provided to support the length of the shafts, but these shoes prevented crystal growth in the area over which they slid and they gave rise to problems of wear, lubrication, etc. Although for some extremely long crystallizer tubes embodying the concept of this invention some intermediate bearing means may be needed, this invention greatly reduces the requirement for such intermediate bearings.

It is, therefore, an object of this invention to provide an agitator or scraper rotor for a tubular crystallizer or the like which is more easily aligned and less subject to bending while in operation.

Another object of this invention is to provide an agitator shaft for a tubular crystallizer which is less costly to fabricate.

A further object of this invention is to provide an agitator rotor or shaft for a tubular crystallizer which has relatively thin walls which are internally pressurized to prevent collapse in service.

Still another object of this invention is to provide an agitator shaft assembly for a tubular crystallizer, which is of substantially the same specific gravity as water, to float within a crystallizer tube.

Yet another object of this invention is to provide an agitator shaft assembly for a tubular crystallizer which greatly reduces the bearing loads of the shaft while it is in service.

Many other objects, advantages, and features of invention reside in the construction, combination, and arrangement of parts involved in the embodiment of this invention and its practice otherwise as may be understood from the following description and accompanying drawing wherein:

FIGURE 1 is a longitudinal, vertical section through a single tube crystallizer according to this invention;

FIGURE 2 is a transverse vertical section taken on line 2—2 of FIGURE 1; and

FIGURE 3 is a section taken on line 3—3 of FIGURE 2 showing one possible form of blade mounting.

Referring to the drawing in detail, a tank 10 has a suitable refrigerant introduced into it through pipe 11 and exhausted through pipe 12. Welded or otherwise fixed within tank 10 is a crystallizer tube 13. Crystallizer tube 13 may extend beyond the end walls 14 and 15 of tank 10 for ease of manifolding. The arrangement shown is merely one illustrative example of a tubular crystallizer. Generally, tank 10 would have a plurality of tubes 13 within it to increase its capacity with an economy of space.

A hollow agitator shaft 20 has an end shaft 21 projecting from one end to be journalled in a bearing 22 fixed over end wall 15 by bolts 23. A drive shaft 24 extends from the other end of shaft 20 to pass through and be journalled in end cap 25 fixed over end wall 14 by means of bolts 26. A suitable packing 27 prevents fluid leakage around shaft 24. A sprocket 28 is mounted on shaft 24 to drive agitator shaft 20.

A number of studs 30 are welded to shaft 20 at intervals along its length. Agitator blades 31 are fixed to the studs 30 by means of the mounting brackets 32 so that the blades 31 are held a spaced distance away from shaft 20 with a slight clearance from the inner surface of crystallizer tube 13.

As shown in FIGURE 3, a mounting bracket 32 is slipped over a stud 30 and fixed to it by means of a threaded locking element 33. The blades 31 may contain laterally elongated apertures allowing the elements 33 passage therethrough. Each blade 31 is then positioned on a row of mounting brackets 32 and held in place by means of blind nuts 34 which are turned down over the ends of the projecting elements 33. When all the blades 31 are thus properly positioned, the blades 31 and the brackets 32 are drilled and tapped to receive the bolts 35 to fix the blades 31 permanently in place. Should it be necessary to adjust the positions of the blades 31 after lengthy service, the nuts 34 may be removed and the elements 33 unscrewed so that the brackets 32 may be repositioned along the studs 30.

While four blades 31 are shown, any desired number may be used. Material to be crystallized is introduced through tube 40 and withdrawn through tube 41. The agitator shaft 20, the blades 31, the brackets 32, and all associated elements are best made of stainless steel for most applications.

As one example of this invention, an agitator shaft 20 thirteen feet long was made of five inch inside diameter pipe, schedule 10, in type 316 stainless steel. This pipe weighed 7.65 pounds per foot. Four blades 31 and fittings weighed 2.2 pounds per foot. Thus total weight per foot was about 9.85 pounds per foot. Buoyancy was about 10.7 pounds per foot. Thus all consideration due to weight when operated in a water solution was eliminated. If heavier schedule 40 five inch inside diameter pipe had been used, it alone would have weighed 14.62 pounds per foot and the assembly would have been 6.12 pounds per foot heavy in a water solution to introduce bending moments.

Further to stiffen the relatively thin walled schedule 10 pipe crystallizer shaft 20 and prevent it from collapsing in service, it may be internally pressurized, for example, to 100 pounds per square inch, with air or a suitable gas through a small channel 44 as shown in FIGURE 1. Channel 44 may then be sealed by a threaded plug or the like. When the crystallizer operates near freezing or below, the internal pressure will still be over 90 pounds per square inch above atmospheric pressure. The use of

the thinner walled pipe in fabricating shafts 20 results in a considerable saving in material costs. Further, the foregoing example is not to be construed to limit the scope of this invention which may be scaled to any crystallizer application.

While this invention has been shown and described in the best form known, it will nevertheless be understood that this is purely exemplary and that modifications may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. In a tubular crystallizer for solutions, having a tank, means introducing a refrigerant into said tank, at least one elongated crystallizer tube passing through said tank, means introducing a solution into one end of said tube to pass through said tube, means withdrawing a solution and crystal slurry from the other end of said tube, wherein an agitator assembly comprises, in combination, an agitator shaft within said tube, bearing means at least at the ends of said shaft rotatably mounting said shaft within said tube, longitudinal agitator means, means mounting said agitator means a spaced distance away from said agitator shaft adjacent to said tube, and means driving said agitator shaft, said agitator shaft being hollow, the improvement in which said agitator shaft, said agitator means, and said mounting means are substantially the same weight per unit of length as the weight of solution displaced by said agitator shaft, said agitator means, and said mounting means per unit of length.

2. The combination according to claim 1 wherein said agitator shaft is tubular and rounded in section.

3. In a tubular crystallizer for solutions having a tank, means introducing a refrigerant into said tank, at least one elongated crystallizer tube passing through said tank, means introducing a solution into one end of said tube to pass through said tube, means withdrawing a solution and crystal slurry from the other end of said tube, wherein an agitator assembly comprises, in combination, an agitator shaft within said tube, bearing means at least at the ends of said shaft rotatably mounting said shaft within said tube, longitudinal agitator means, means mounting said agitator means a spaced distance away from said agitator shaft adjacent to said tube, and means driving said agitator shaft, said agitator shaft being hollow, said agitator shaft, said agitator means, and said mounting means being substantially the same weight per unit of length as the weight of solution displaced by said agitator shaft, said agitator means, and said mounting means per unit of length, the improvement which includes gas under pressure within said hollow tubular agitator shaft.

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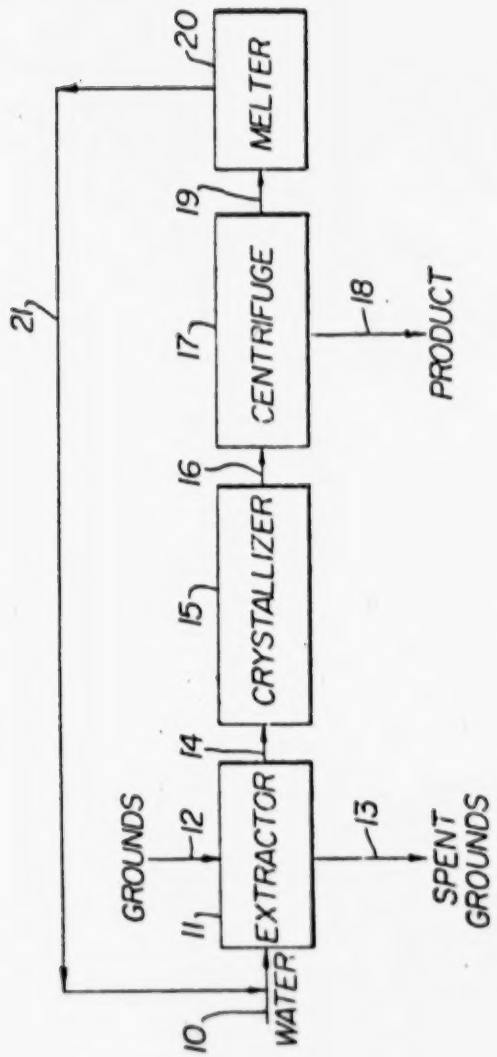
Sept. 29, 1970 N. GANIARIS 3,531,295

FREEZE CONCENTRATION OF COFFEE EXTRACT

Original Filed Dec. 8, 1965



United States Patent Office 3,531,295 Patented Sept. 29, 1970

3,531,295
FREEZE CONCENTRATION OF COFFEE EXTRACT

Neophytos Ganiaris, Riverdale, N.Y., assignor, by mesne assignments, to Struthers Patent Corporation, Houston, Tex., a corporation of Texas

Continuation of application Ser. No. 512,365, Dec. 8, 1965. This application Apr. 16, 1969, Ser. No. 816,596
Int. Cl. A23f 1/08
U.S. Cl. 99—71 5 Claims

ABSTRACT OF THE DISCLOSURE

A process of freeze concentrating coffee extract is described in which a mixture of ice and coffee is separated in a centrifuge. The ice is thereafter washed to include a finite amount of coffee and melted to recover entrained coffee solids therefrom.

This application is a continuation of my copending application Ser. No. 512,365, filed Dec. 8, 1965 and now abandoned.

This invention relates to an improvement in a process for the preparation of concentrated comestible extracts and is particularly applicable to the preparation of soluble coffee solids, or "instant coffee." More particularly, this invention relates to the preparation of aqueous coffee extracts and the concentration of the extract by partial freezing of the aqueous concentrate.

Soluble or "instant" coffee has been prepared by first extracting coffee beans with hot water and subsequently dehydrating the extract by spray drying under vacuum conditions. This process has met with vast commercial success, but the flavor of the soluble coffee leaves much to be desired. The vacuum conditions employed not only remove water from the extract, but also cause volatile taste and flavor elements of the coffee to evaporate. The resulting soluble product is, therefore, never as good as the extract from which it is prepared.

To improve the flavor of the soluble coffee, it has been often proposed to remove substantial amounts of water in the extract by partially freezing the extract and separating the resulting pure ice crystals from the concentrated extract. This process of partial freezing is then followed by a complete dehydration under vacuum conditions. In this way, the coffee loses less of the volatile components by virtue of the fact that the extract is subject to vacuum conditions for shorter periods of time.

In a preferred embodiment of the concentration process, freshly roasted coffee grounds are extracted countercurrently with hot water and the extract produced is partially frozen by indirect refrigeration in a suitable crystallizer and the resulting slurry of ice and concentrate is subjected to centrifugation to separate the ice from the concentrate. In order for the process to be economical, this separation and the subsequent water wash of the crystals on the centrifuge basket must effect a relatively complete removal of mother liquor from the ice crystals.

This problem of ice-aqueous extract separation is not a problem exclusive to coffee extracts alone, but is also encountered in the preparation of other concentrated extracts of comestible materials. Thus, the process of this invention is also applicable for the improved preparation of concentrated extracts of comestible extracts such as tea, chicory or the like.

It is, therefore, an object of this invention to provide an improved process to preparing extracts of comestible products, and the concentrating of said extracts by partial freezing.

Another object of this invention is to provide an improved process for extracting and concentrating soluble coffee solids wherein the concentrating is by partial freezing of the extract.

The objects of this invention are accomplished by a process which comprises the preparation of a comestible extract by extraction, concentration of the extract by partial freezing of the water therefrom, separating the mixture resulting from the partial freezing, melting the ice having adhering mother liquor, and returning the melt to the extraction step.

A preferred embodiment of this invention is a process which comprises extracting coffee beans at elevated temperature with water, removing part of the water by partial freezing, separating the resulting ice from the mother liquor, and melting the ice with subsequent recycling of the solution produced to the extraction step so as not to expend valuable coffee concentrate which adheres to or is occulded in the ice. In one preferred embodiment of this invention the ice-coffee concentrate slurry is separated using a rotating basket centrifuge.

A particularly preferred embodiment of this invention comprises preparing and concentrating the extract as above, separating ice crystals from the concentrated extract and then washing the ice crystals prior to melting and recycle to the extraction step.

Washing of the ice is normally during centrifugation and is most desirable when the mother liquor of the slurry contains about 20 percent or more dissolved coffee solids by weight. It has been found that at concentrations above about 20 percent the high viscosity of the mother liquor limits the separation efficiency of the centrifuge and excessive amounts of solids remain with the ice which is melted. However, at concentrations below 20 percent washing is not necessary according to this invention.

The initial steps in the process of preparing instant coffee are the same as preparing regular coffee. Following roasting, the coffee is ground, but the granulation may be extremely coarse and, in some cases, fine particles that may result from grinding are sieved out and used elsewhere.

The grounds are placed in closed containers known as extractors. These extractors are set up in batteries with several extractors to a battery.

Ground coffee and hot water are charged into the first extractor. The coffee is then extracted until the necessary materials have been removed from the grounds. The resulting extract is then charged into the second extractor containing fresh coffee. The second extractor is run until extraction is completed. The resulting coffee extract (which is now stronger than ordinary coffee beverage) is placed in the third extractor containing fresh grounds and the brewing process is again repeated.

In commercial plant operation, the process is conducted in a semi-continuous manner, the fresh water coming into an extraction battery first reaches the extractor having the most spent, exhausted grounds and proceeds from there to the next most spent grounds and so on until, finally in the last extractor it reaches the fresh, most recently added grounds. This is known as countercurrent extraction system.

Temperature and pressure in the extractor system will vary greatly. Coffee being produced from fresh grounds is usually processed at low temperature with low pressure. Coffee being produced from spent, exhausted grounds is extracted at high temperature and under high pressure.

The coffee extract to be concentrated by freeze concentration can have any coffee solids content from a few percent such as 10 percent to as high as 40 to 50 percent. That is, there may be as much as 40 to 50 lbs. of coffee solids in the extract for each 100 lbs. of extract. However, the lower the solids content of the extract, the more the water which must be removed during the freeze concen-

tration and drying steps. On the other hand, it has been found that carrying the extraction process to the point where high coffee solids content can be achieved often lowers the flavor of the extract. Thus, a preferred range of coffee solids content of the extract for the practice of this invention is from about 15 to 30 percent coffee solids.

The concentrated coffee solution resulting from extraction is then subjected to concentration by partial freezing of the water therefrom. This freeze concentration process can be conducted in batch, semi-continuous or continuous apparatus according to methods known to the art and improvements of the methods. However, any method of removing the water from the coffee extract by crystallization as ice is applicable to the process of this invention. The resulting slurry of ice and concentrated coffee extract is then subjected to centrifugation to free the concentrated solution of the ice crystals. The resulting ice crystals are ordinarily washed with water or dilute coffee extract to free the ice crystals of mother liquor and the washings may be returned to the freeze concentration process. Normal washing will not completely remove all remaining traces of adhering mother liquod from the ice crystals. Only upon exhaustive washing will the ice crystals be essentially free of mother liquor. However, recycle of wash water containing these valuable dissolved coffee solids would not be economic under conditions of exhaustive washing because the heat transfer surfaces of the crystallization vessels would have to be proportionally larger to provide for greater quantities of ice crystals which must be formed in the vessels. After the ice is removed from the centrifuge it is melted in a suitable vessel. The solution produced will normally contain up to 10 percent by weight of dissolved coffee solids. However, it is preferred to adjust the process conditions so that the melted ice will contain up to 5 percent by weight of dissolved coffee solids. By adjusting the conditions so that the melted ice will contain the lowest amount of dissolved coffee solids possible, it can be seen that an economic advantage can be realized in that less heat transfer surface within the crystallizer will be required. This solution is recycled to the extraction step in lieu of fresh water to prepare additional extract, thus utilizing all of the dissolved coffee solids adhering to the ice crystals from the centrifugation step.

The freeze concentration of the extract can be accomplished in either a single stage or in a plurality of stages each of which comprises a crystallizer in which heat is removed from the coffee extract to form a slurry of ice crystals and concentrated mother liquor. After each crystallization stage, ice is removed from the slurry and the concentrated extract either goes to further processing in the preparation of soluble or powdered coffee or is further concentrated in a subsequent stage of the freeze concentration process. The crystallization of ice from the extract is preferably carried out in a tubular heat exchanger, the outside surfaces of which are cooled by a circulating refrigerant. The internal section of the tube is ordinarily fitted with a shaft on which is located agitator paddles. Alternatively, a conventional scraped surface tubular heat exchanger may be employed. Any acceptable separating device or centrifuge may be employed for separating the concentrated coffee extract from the resulting ice crystals. This centrifuge is the preferred method for separating ice from the mother liquor and ordinarily consists of a rotating basket which contains perforations for allowing passage of the mother liquor. The centrifuge may also be equipped with some means for washing residual mother liquor from the ice crystals.

Referring now to the drawing accompanying this application, freshly roasted coffee grounds enter an extracting apparatus 11 through feed line 12. Water from line 10 also enters the extractor where the coffee solution is brewed. After brewing, the spent grounds are discharged through line 13, and the brew passes through line 14 and enters crystallizer 15 where the temperature is lowered sufficiently to cause ice to form in the extract. The exact degree of concentration depends upon the cooling medium, the temperature, and residence time in the crystallizer. Concentrated slurry of ice and coffee solution is conveyed to the centrifuge 17 by way of line 16. The centrifuge has a rotating basket consisting of an open screen material which allows concentrated coffee solution removal from the outside periphery of the centrifuge through line 18 while the ice passes to the melter 20 by way of line 19. Complete separation of ice and coffee solution is not effected in the centrifuge even though washing may be employed. In the melting apparatus 20, the ice with adhering or occluded concentrated coffee solution is melted to result in dilute coffee solution. This solution leaves the melter through recycle line 21, and enters line 10 where it mixes with the process water for reprocessing.

The following examples are illustrative of the process of this invention.

EXAMPLE 1

Ground coffee and water are charged to a countercurrent extractor and extracted to result in an extract containing 24 percent soluble coffee solids. This extract was continuously metered into a crystallizer wherein 10 pounds per minute of water formed individual ice crystals to result in a slurry of concentrated coffee, having 32 percent soluble coffee solids and ice. This slurry was conveyed to a centrifuge having a basket rotating at 2200 revolutions per minute and a wash water rate of 4 pounds of fresh water per minute. The concentrated solution of coffee was discharged through the perforated rotating basket as product at the rate of 30 pounds per minute and contained 32 percent soluble coffee solids. The ice, upon melting, was found to contain 1.3 percent soluble coffee solids.

EXAMPLE 2

The general procedure of Example 1 was repeated except that the dilute coffee solution resulting from melting the ice was recycled to extractor. The resulting extract having 24.5 percent soluble coffee solids was metered into the crystallizer. The slurry produced was centrifuged and the concentrate leaving the centrifuge as product at the rate of 30 pounds per minute was found to contain 32.5 percent soluble coffee solids, thus providing 13 more pounds of coffee as product per 1000 pounds extracted.

The process of this invention is applicable to any aqueous concentrate of a comestible material which is to be extracted, and then concentrated by formation of ice and subsequent removal of ice. Thus, the process of this invention may also be used in connection with the freeze concentration of tea.

Although the invention has been described with reference to particular embodiments thereof, it is to be understood that various changes may be made without departing from the spirit of the invention as defined by the scope of the attendant claims.

What is claimed is:

1. A process for preparation of concentrates of coffee which comprises:

(a) extracting roast ground coffee with hot water to form an aqueous extract having 15–30% dissolved solids therein;

(b) partially freezing said extract to form a mixture of ice and more concentrated extract having at least 20% dissolved solids therein;

(c) separating said ice from said more concentrated extract by centrifuging under conditions whereby a portion of said more concentrated extract adheres to said ice;

(d) reducing the amount of said more concentrated extract adhering to said ice to a finite amount less than 5% by weight of said ice by washing and centrifuging;

(e) melting said ice to a solution containing dissolved extract which is less than 5% by weight of said melted ice; and

(f) recovering coffee solids from said melted ice.

2. A process according to claim 1 in which the solution from step (e) is used in step (a) to form additional concentrated extract, thereby preventing loss of soluble coffee solids as a result of step (c).

3. A process for the preparation of concentrates of coffee which comprises:

(a) extracting roast ground coffee with hot water to form an aqueous extract having 15–30% dissolved solids therein;

(b) partially freezing said extract to form a mixture of ice and a more concentrated extract having at least 20% dissolved solids therein;

(c) separating said ice from said more concentrated extract by centrifuging under conditions whereby a portion of said more concentrated extract adheres to said ice;

(d) reducing the amount of said more concentrated extract adhering to said ice to a finite amount of dissolved extract solids, less than 5% by weight of said ice, by washing in a centrifuge with fresh water or dilute coffee extract and centrifuging;

(e) melting the ice and combining said ice melt and said adhering extract therein from step (d) with liquid coffee extract to form a combined extract; and

(f) recovering coffee solids from said combined extract.

4. The process of claim 1 wherein the amount of said more concentrated extract adhering to said ice crystals is reduced in step (d) by washing the ice crystals with water resulting in spent water and ice crystals, each having small amounts of said extract.

5. A method according to claim 1 in which coffee solids are recovered from the washings of the ice.

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MAURICE W. GREENSTEIN, Primary Examiner

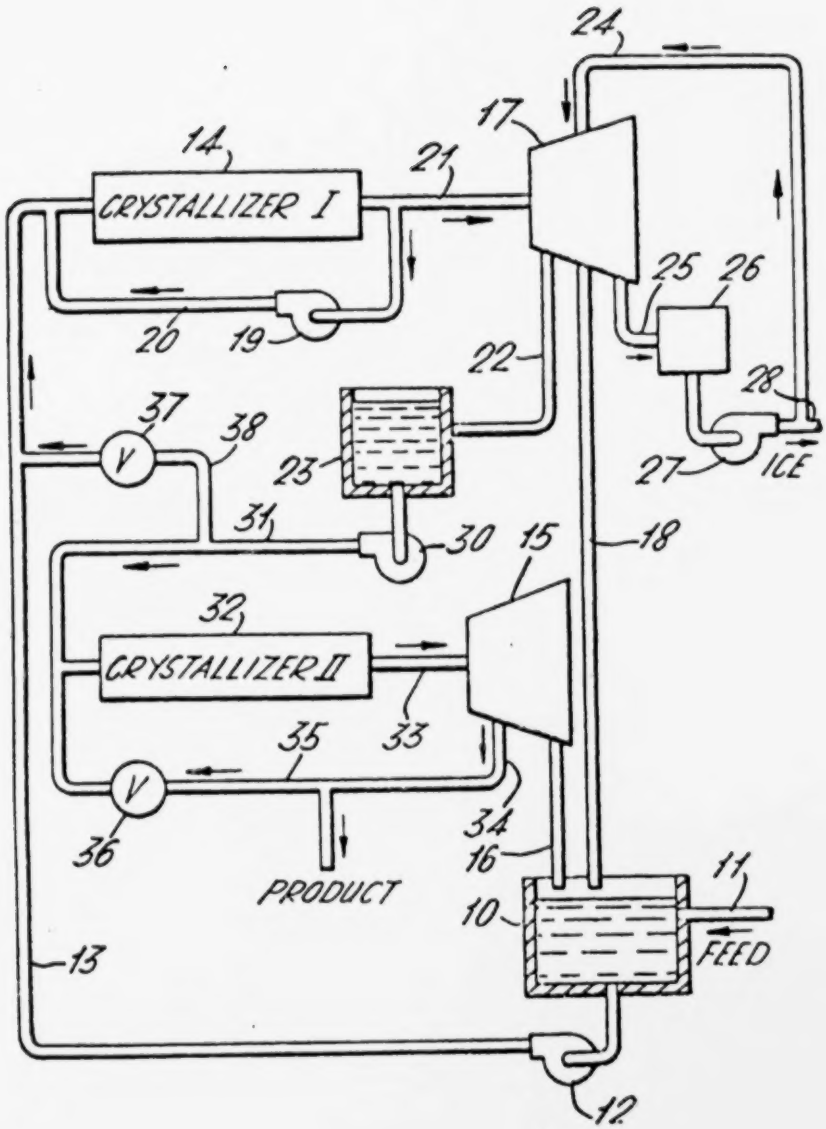
U.S. Cl. X.R.

62—58; 99—77, 199, 205

Nov. 16, 1971 N. GANIARIS 3,620,034

MULTI-STAGE FREEZE CONCENTRATION OF COFFEE

Filed July 11, 1967



United States Patent Office

3,620,034
Patented Nov. 16, 1971

3,620,034

MULTI-STAGE FREEZE CONCENTRATION OF COFFEE

Neophytos Ganiaris, Riverdale, N.Y., assignor to Struthers Patent Corporation, Houston, Tex.

Continuation-in-part of abandoned application Ser. No. 512,365, Dec. 8, 1965, which is a continuation-in-part of application Ser. No. 321,020, Nov. 4, 1963. This application July 11, 1967, Ser. No. 652,532
Claims priority, application Great Britain, July 15, 1966, 31,831/66
The portion of the term of the patent subsequent to Nov. 8, 1983, has been disclaimed
Int. Cl. B01d 9/04; A23f 1/08
U.S. Cl. 62—58 5 Claims

ABSTRACT OF THE DISCLOSURE

In a staged freeze concentration process for concentrating coffee solution, ice crystals are removed from the system after the first stage from less concentrated coffee solution. Ice crystals removed from the more concentrated coffee solution in the second stage are added to incoming feed. Coffee solution from which ice crystals are separated in the second stage is removed from the system as a product.

This application is a continuation-in-part of application Ser. No. 512,365, filed Dec. 8, 1965, and forfeited on June 20, 1969, which is a continuation-in-part of Ser. No. 321,020, filed Nov. 4, 1963 and now Pat. No. 3,283,522 of Nov. 8, 1966.

BACKGROUND OF THE INVENTION

In the freeze concentration of coffee, a coffee solution is passed through a series of crystallizers to provide a slurry of ice crystals in a concentrated coffee solution. The ice crystals are separated from the concentrated coffee solution in a centrifuge and washed. Even when crystals of a uniform and optimum size are produced, considerable valuable coffee solids may be lost with ice crystals from which it is difficult to remove the more concentrated coffee solution.

SUMMARY OF THE INVENTION

This invention provides for the centrifuging of ice crystals from a multi-stage freeze concentration system for coffee which provides coffee solution at a concentration of over 37% from a feed at a concentration of about 26% by centrifuging and removing the ice crystals from the system in a first centrifuge which separates crystals from a coffee solution at a concentration of less than 30% leaving an early or first stage crystallizer. The solution from the first centrifuge is passed through an additional crystallizer and a second centrifuge from which a product stream of a coffee solution of over 37% is withdrawn, ice from the second centrifuge being recycled by being added to the feed.

BRIEF DESCRIPTION OF THE DRAWING

The figure of the drawing is a schematic diagram of a system for the freeze concentration of coffee according to this invention.

Referring to the drawing in detail, a feed solution of 26% by weight coffee dissolved solids enters feed tank 10 through pipe 11. Pump 12 draws this solution from feed tank 10 and passes it through pipe 13 to enter crystallizer 14. The solution passing through pipe 13 from tank 10 will be from 13% to 24% coffee dissolved solids. This lower coffee content results from the fact that the solution is diluted because ice enters tank 10 from centrifuge 15 through pipe 16 and because wash water from centrifuge 17 passes into tank 10 through pipe 18. Thus wash water and the melted ice dilute the feed solution entering crystallizer 14.

A pump 19 may partially recirculate through pipe 20 the slurry of ice crystals and coffee solution leaving crystallizer 14 until the coffee solution contains 26 to 30% coffee dissolved solids. This slurry then passes through pipe 21 to enter centrifuge 17. Mother liquor is separated from the ice crystals in centrifuge 17 and passes through pipe 22 to the mother liquor tank 23. Wash water enters centrifuge 17 through pipe 24 to wash ice crystals therein and flow to tank 10 through pipe 18. Ice passes from centrifuge 17 through pipe 25 to enter the ice tank 26. Some ice melts in tank 26 to be recirculated by pump 27 through pipe 24 as wash water. Ice passes from the system through pipe 28.

The 26 to 30% coffee dissolved solids solution in mother liquor tank 23 is pumped by pump 30 through pipe 31 to the second stage crystallizer 32. A slurry of ice crystals in at least a 37% coffee solution leaves crystallizer 32 through pipe 33 to enter centrifuge 15. The 37% coffee dissolved solids solution leaves centrifuge 15 through pipe 34 as a product. By means of pipe 35 and valve 36, this solution may be recirculated through crystallizer 32.

By means of valve 37 and pipe 38 mother liquor may be recirculated through crystallizer 14. This recirculation is required to raise the concentration of the solution in pipe 13 entering crystallizer 14 above the concentration of the feed while keeping it below 30% coffee dissolved solids. Excessive recirculation through pipe 20 could also serve to concentrate the feed from pipe 13, but this would result in too high a percentage of ice crystals in the crystallizer 32 which would reduce the rate of crystal growth. Recirculation through pipes 20 and 38 should be balanced and controlled so that the percentage of ice crystals by weight in solution in crystallizer 14 is between 20 and 30%. If the percentage of ice crystals is too low, below 15% by weight, as when pipe 20 is not used for recirculation, excessive nucleation and small and non-uniform crystals result which are difficult to centrifuge. When centrifuging ice crystals from the system from a 26 to 30% solution as described, less than 1% coffee solids by weight will be lost with the ice.

While this invention has been shown and described in the best form known, it will nevertheless be understood that this is purely exemplary and that modifications may be made without departing from the spirit and scope of the invention except as it may be more limited in the appended claims wherein:

What is claimed is:

1. A process for the preparation of a concentrate of coffee from a liquid containing about 24% coffee solids which comprises (a) partially freezing aqueous coffee extract in at least two serially connected crystallizer passes to form a mixture of about 20–30% by weight of ice and a concentrated extract, (b) separating said ice by centrifugation from said mixture under conditions whereby a portion of said concentrated extract adheres to said ice, (c) reducing the amount of said concentrated extract adhering to said ice by centrifuging and by washing in the centrifuge with addition of wash water or melted ice (d) melting the ice to form a dilute solution which contains the coffee which had been adhering to the ice and (e) recovering coffee solids from said melted ice.

2. In the freeze concentration of coffee according to claim 1, the steps of:

(a) removing ice from the concentrated coffee solution and mixing the ice with feed solution to melt therein; and

(b) removing the concentrated coffee solution from the system as a product.

3. The process according to claim 2 with the additional steps of:

(a) melting to some extent the ice removed from coffee solution to form a wash liquid;

(b) washing ice with the wash liquid; and

(c) recycling the wash liquid after washing ice into the feed.

4. The process according to claim 3 with the additional step of:

recycling at least some of the concentrated coffee solution into the feed.

5. A process as claimed in claim 1 in which coffee solids are recovered from wash water after washing.

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NORMAN YUDKOFF, Primary Examiner

R. T. FOSTER, Assistant Examiner

U.S. Cl. X.R.

99—71, 199, 205

PATENTED JAN 25 1972

3,636,722

SHEET 1 OF 2

Fig. 1.

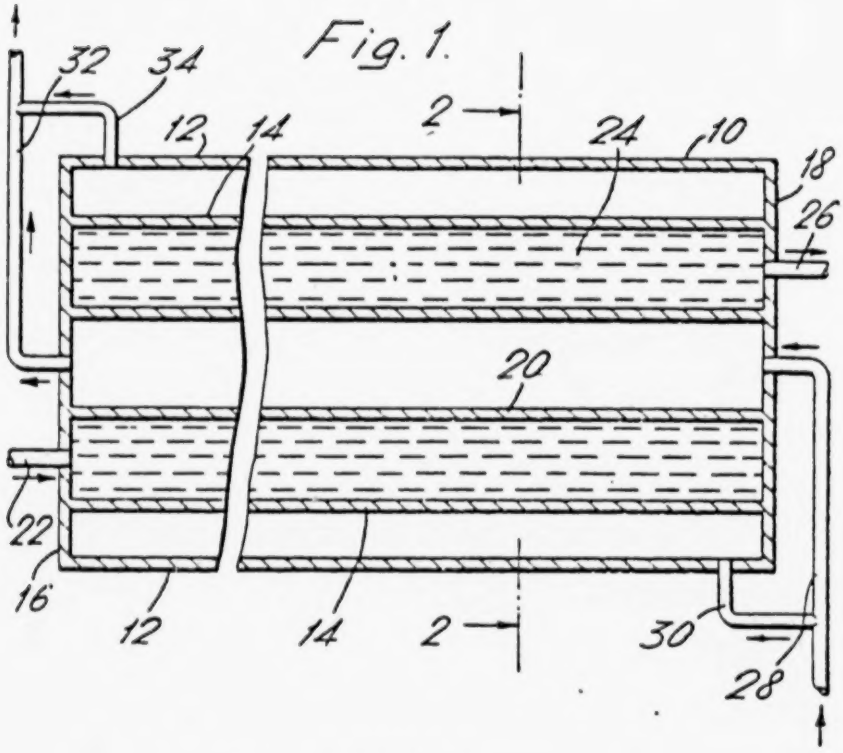

Fig. 2.

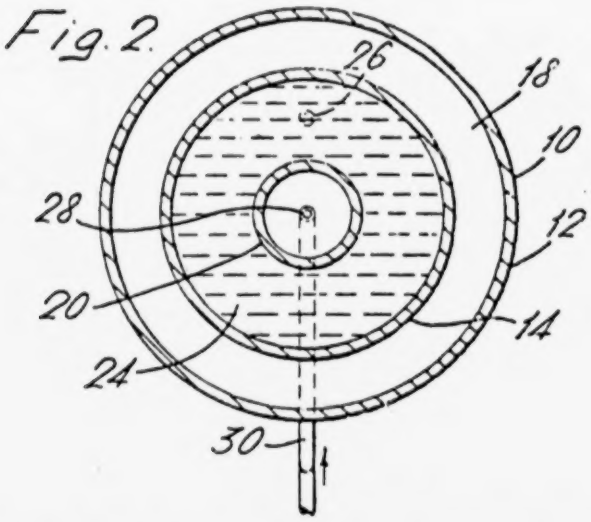

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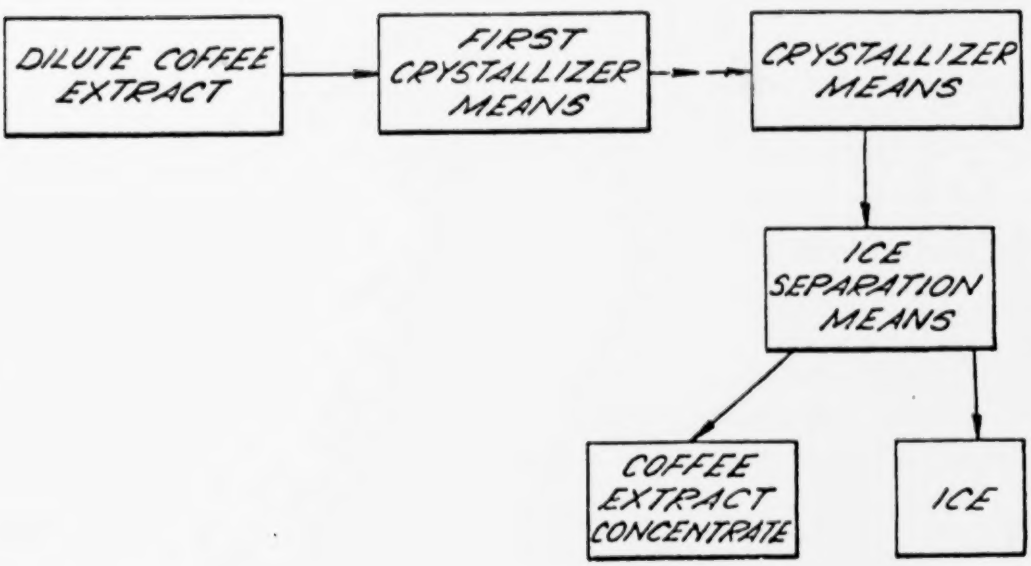
Fig. 3.



United States Patent

Ganiaris

[11] 3,636,722

[45] Jan. 25, 1972

[54] CONCENTRATION OF COFFEE

[72] Inventor: Neophytos Ganiaris, Riverdale, N.Y.

[73] Assignee: Struthers Patent Corporation, Huntsville, Tex.

[22] Filed: Nov. 25, 1969

[21] Appl. No.: 879,843

Related U.S. Application Data

[62] Division of Ser. No. 651,451, July 6, 1967, abandoned.

[30] **Foreign Application Priority Data**

July 15, 1966 Great Britain 31,832/66

[52] U.S. Cl. ..... 62/123, 99/199, 99/236 C

[51] Int. Cl. A23f 1/06

[58] Field of Search ..... 62/123, 340, 354, 58; 34/5; 99/236, 316, 199 C, 205 C

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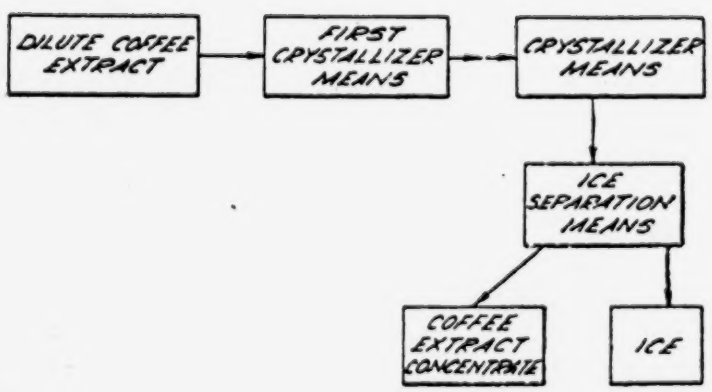
Primary Examiner—William E. Wayner

Attorney—William A. Drucker

[57] **ABSTRACT**

In a system for the freeze concentration of coffee, the ratio of the area of the heat transfer surfaces of the crystallizer to the volume of the crystallizer should be between 7:1 to 10:1. To accomplish this ratio, a crystallizer having both a jacket and a central passage for refrigerant may be used.

2 Claims, 3 Drawing Figures



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CONCENTRATION OF COFFEE

This application is a division of my copending application Ser. No. 651,451, filed July 6, 1967, now abandoned.

BACKGROUND OF THE INVENTION

It has been found that coffee solids are precipitated out of a water solution when the solution is cooled to low temperatures between 20° and 32° F. and maintained at these temperatures for prolonged periods of time.

In the freeze concentration of coffee solutions containing from 20 to 45 percent solids, the solution must be cooled in the freeze concentration system to temperatures of 20° to 32° F. Thus, residence time of a coffee solution in a crystallizer and in associated ice crystal removing apparatus and piping should not be for a prolonged time. With a prolonged residence time, coffee solids will be precipitated out of solution in large quantities. The formation of precipitates in the freeze concentration of coffee should be minimized for three reasons.

1. The precipitate tends to be removed from the system with ice crystals leaving a final product of inferior flavor and aroma.
2. The precipitate affects the efficiency of the crystallizer since it is deposited on heat transfer surfaces.
3. The precipitate plugs up centrifuge screens and other ice crystal separating apparatus.

SUMMARY OF THE INVENTION

To avoid the problem of precipitation, a freeze concentration system for coffee extracts should be designed to have a residence time of less than 2.5 hours. Therefore, the entire volume of the freeze concentration system (pipelines, tanks, crystallizers, etc.) should be less than 2.5 times the hourly flow rate through the system. Pipelines and other elements can be designed on the basis of known technology and engineering principles to provide a minimum volume and a short residence time. However, in the case of crystallizers, other factors must be considered to determine the optimum residence time since the growth of ice crystals is a function of the time spent within the crystallizers.

The heat of crystallization must be removed through heat transfer surfaces of a crystallizer. These surfaces, of course, define the size of the crystallizer for a given temperature gradient and heat transfer coefficient. The design limits, heat transfer coefficients, degree of gradiation, and temperature differences are established on the basis of their effect on ice crystal growth.

The only known design parameter that affects both the ice crystal growth and the precipitate formation is the residence time within the crystallizer. Therefore, a relation of heat transfer area to volume for a crystallizer must be determined in order to insure a maximum crystal growth rate without precipitate formation.

This design parameter for a freeze concentration system for coffee extracts has been found to be a ratio between 7:1 to 10:1 for the area of the heat transfer surfaces to the volume of the freeze concentration crystallizer. To accomplish this design parameter, a crystallizer may have a jacket and a central passage for refrigerant to increase the heat transfer area for a given volume.

Thus it may be seen that this invention provides a more efficient freeze concentration system for coffee solutions.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal, vertical section through a crystallizer according to this invention with a central portion broken away; and

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FIG. 2 is a transverse vertical section taken on line 2—2 of FIG. 1;

FIG. 3 is a flow chart showing plural crystallizers used in a coffee concentration system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing in detail, a crystallizer 10 has an outer shell 12 and an inner shell 14 extending between the end plates 16 and 18. A cylindrical inner refrigerant passage 20 extends within inner shell 14 between plates 16 and 18. Coffee solution 24 is introduced through pipe 22 and a slurry of coffee solution and ice crystals is withdrawn through pipe 26 from the annulus formed between passage 20 and inner shell 14. Refrigerant enters outer shell 12 and one end of passage 20 through the pipes 28 and 30 and refrigerant is withdrawn through the pipes 32 and 34.

While not shown, agitator blades or the like may be placed between passage 20 and shell 14 to prevent crystals from forming on these heat transfer surfaces. In addition, a series of crystallizers may be used in sequence if desired. This particular crystallizer construction enables the crystallizer volume for a given amount of ice crystal production to be reduced.

However, in the design of any crystallizer for the freeze concentration of coffee without precipitate formation, there should be a certain ratio, within limits, between the volume of the crystallizer and the heat transfer area. This may be expressed as the following design equation:

$$\frac{\text{Volume of the crystallizer in cubic feet}}{\text{Heat transfer area in square feet}} = \frac{1}{7} \text{ to } \frac{1}{10} \text{ feet}$$

While this equation is valid for all systems for the freeze concentration of coffee without forming precipitates, the crystallizer shown will require a lower volume for a given crystal product and thus reduce the total cost of the apparatus.

While this invention has been shown and described in the best form known, it will nevertheless be understood that this is purely exemplary and that modifications may be made without departing from the spirit and scope of the invention except as it may be more limited in the appended claims.

What is claimed is:

1. An apparatus system for concentration of aqueous liquid coffee solution containing from 20 to 45 percent dissolved coffee solids, comprising:
   a. plural serially connected crystallizer means, each having an outer shell, and an inner shell having a cylindrical heat transfer surface, forming ice therein at coffee temperatures down to 20° F.,
   b. inlet and outlet means coupled to said crystallizer means to allow refrigerant to pass across the outside of the heat transfer surface of the inner shell, and coffee solution to pass across the inside of the heat transfer surface of the inner shell through a crystallization zone having an annular cross section,
   c. the ratio of the total annular volume of said crystallizer means inner shell to the area of said inner shell heat transfer surface being sufficient to avoid precipitate formation from coffee, said annular volume being provided by a hollow axial central cylindrical member within said inner shell,
   d. means to provide a flow rate of said coffee solution through the annular crystallization zone of each said crystallizer means of greater than 40 percent per hour of the volume of each said crystallizer means, and
   e. means separating ice from said coffee extract after passage through at least two serially connected crystallizer means.

2. An apparatus system according to claim 1 including coffee agitation means within said annular crystallization zone.

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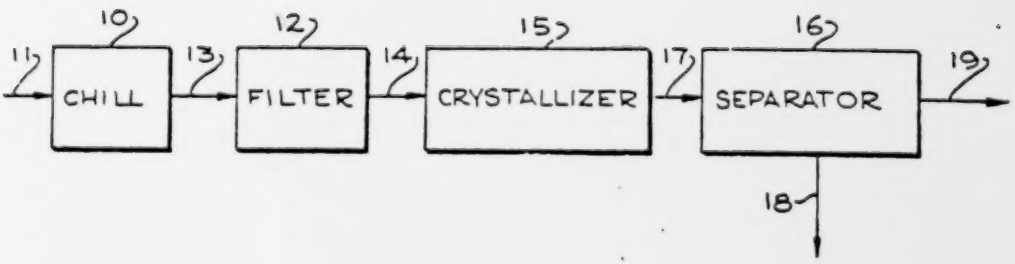
April 30, 1968 R. G. REIMUS ET AL 3,381,302

FREEZE CONCENTRATION OF COFFEE EXTRACT

Filed Dec. 2, 1965



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Patented Apr. 30, 1968

3,381,302

FREEZE CONCENTRATION OF COFFEE EXTRACT

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Filed Dec. 2, 1965, Ser. No. 511,173
3 Claims. (Cl. 99—71)

ABSTRACT OF THE DISCLOSURE

A process is described for the concentration of comestible liquids by partially freezing ice therefrom and separating the ice from the concentrated liquid. Prior to freezing the ice the liquid is chilled to a temperature no lower than about 32° F. which is near to, but substantially above, the freezing point and the liquid is prefiltered so that waxes and similar material are removed before the ice is formed.

This invention relates to an improvement in a process for the preparation of concentrated comestible liquids and liquid extracts and is particularly applicable to the preparation of soluble coffee solids or "powdered coffee." More particularly, this invention relates to the pre-treatment of liquids and liquid extracts as a step preliminary to removal of water from the extract by a freezing process.

Soluble, or "powdered," coffee has been prepared by first extracting coffee beans with hot water and subsequently dehydrating the extract by spray drying under vacuum conditions. This process has met with vast commercial success, but the flavor of the soluble coffee leaves much to be desired. The vacuum conditions employed not only remove water from the extract, but also cause volatile taste and flavor elements of the coffee to evaporate. The resulting soluble product is, therefore, never as good as the extract from which it is prepared.

To improve the flavor of the soluble coffee, it has been often proposed to remove substantial amounts of water in the extract by partially freezing the extract and separating the resulting pure ice crystals from the concentrated extract. This process of partial freezing is then followed by a complete dehydration by evaporation of water which may be conducted under vacuum conditions. In this way, the coffee loses less of the volatile components by virtue of the fact that the extract is subject to evaporation conditions for shorter periods of time.

In a preferred embodiment of the freezing process, the coffee extract is partially frozen by indirect refrigeration in a suitable crystallizer and the resulting slurry of ice and concentrate is subjected to centrifugation to separate the ice from the concentrate. In order for the process to be economical, this separation and the subsequent water wash of the crystals on the centrifuge basket must effect a relatively complete removal of mother liquor from the ice crystals.

However, when coffee extract is cooled to near its initial freezing point, a gummy or waxy solid material often precipitates from solution prior to ice formation. This wax or tar is carried along with the ice crystals and coffee extract into the centrifuge and collects on the centrifuge basket, eventually plugging the basket and preventing the complete separation of ice from concentrated extract.

This problem of the precipitation of insoluble materials in the coffee extract is not a problem exclusive to coffee extracts alone, but is also encountered in the preparation of other concentrated extracts of comestible materials. Thus, the process of this invention is also applicable to the preparation of concentrated extracts of such

comestible materials as tea, grape juice, apple juice, beer and orange juice.

It is therefore an object of this invention to provide an improved process for the concentration of comestible liquids and liquid extracts by partial freezing of the liquid or liquid extracts.

Another object of this invention is to provide a process in which a comestible liquid or liquid extract, free of insoluble elements at the freezing temperature of ice, is subjected to freeze concentration.

Yet another object of this invention is to provide an improved process for the concentration of coffee extract by partial freezing of the extract.

Still another object of this invention is to provide a process in which coffee extract, free of insoluble elements at the freezing temperature of ice, is subjected to freeze concentration.

The objects of this invention are accomplished by a process which comprises preparing a comestible liquid or liquid extract, cooling the liquid to precipitate material insoluble at the temperature at which ice forms therein, removing insolubles from the resulting mixture and then subjecting the insoluble-free mixture to concentration by partial freezing of water therefrom.

A preferred embodiment of this invention is a process which comprises extracting coffee beans at elevated temperatures with water to produce a coffee extract, cooling the extract to precipitate materials insoluble at the temperature at which ice forms in the brew, removing insolubles from the resulting mixture and then subjecting the insoluble free mixture to concentration by partial freezing of water therefrom.

The initial steps in the process of preparing instant coffee are the same as preparing regular coffee. Following roasting, the coffee is ground, but the granulation may be extremely coarse and, in some cases, fine particles that may result from grinding are sieved out and used elsewhere.

The grounds are placed in closed containers known as extractors. These extractors are set up in batteries with several extractors to a battery.

Ground coffee and hot water are charged into the first extractor. The coffee is then extracted until the necessary materials have been removed from the grounds. The resulting extract is then charged into the second extractor containing fresh coffee. The second extractor is run until extraction is completed. The resulting coffee extract (which is now stronger than ordinary coffee beverage) is placed in the third extractor containing fresh grounds and the brewing process is again repeated.

In commercial plant operation, the process is conducted in a semi-continuous manner, the fresh water coming into an extraction battery first reaches the extractor having the most spent, exhausted grounds and proceeds from there to the next most spent grounds and so on until, finally, in the last extractor it reaches the fresh, most recently added grounds. This is known as a counter-current extraction system.

Temperature and pressure in the extractor system will vary greatly. Coffee being produced from fresh grounds is usually processed at low temperature with low pressure. Coffee being produced from spent, exhausted grounds is extracted at high temperature and under high pressure.

The coffee extract to be concentrated by freeze concentration can have any coffee solids content from a few percent to as high as 40 to 50 percent. That is, there may be as much as 40 to 50 lbs. of coffee solids in the extract for each 100 lbs. of extract. However, the lower the solids content of the extract, the more the water which must be removed during the freeze concentration and dry-

ing steps. On the other hand, it has been found that carrying the extraction process to the point where high coffee solids content can be achieved often lowers the flavor quality of the extract. Thus, a preferred range of coffee solids content of the extract for the practice of this invention is from about 10 to 30 percent coffee solids.

In prior art processes, after leaving the extractor system, the coffee extract is clarified of sediment while still at an elevated temperature. One of the most common methods of clarification is by means of a centrifuge in which the coffee liquid is passed through a rapidly rotating cylinder and discharges the clear liquid. Another method is by means of a pressure pump forcing the concentrate through porous paper or cloth.

However, according to one embodiment of the process of this invention, the hot coffee extract is first chilled to near the freezing point so that waxes, tars and gums which are soluble in the hot extract are precipitated therefrom. The cold extract is then subjected to filtration or centrifugation to free it, not only of the precipitated gums, tars and waxes, but also from any sediment resulting from the extraction process.

Because the initial freezing point of the coffee extract is dependent on the total coffee solids content of the extract, the temperature to which the extract should be chilled to precipitate the gums, tars and waxes varies with the exact nature of the extract. Ordinarily, however, minimum temperatures of 40° F. and below may be employed in the process of this invention. If it is not desired to form ice in the extract during the precipitation process, the temperature to which the extract is chilled should not be below the initial freezing point. For a coffee extract having 30 wt. percent coffee solids, the temperature is about 27° F.

In practice, it has been found that the tars, waxes and gums will begin to precipitate from coffee at temperatures as high as about 80° F. and that the major portion of insolubles will precipitate at temperatures above 32° F. Thus, an embodiment of this invention comprises chilling the extract to between 80 and 32° F. prior to filtration and freeze concentration. Preferred temperatures for the chilling operation are between about 45 and 32° F. because this temperature range insures virtually complete removal of insolubles.

The coffee extract may be chilled by any convenient means. However, it is preferred to keep the extract under agitation so that the wax and gums formed during the precipitation step do not adhere to the heat transfer surface of the refrigeration means used to precipitate. If desired, the chilled extract may be held at the low temperature for from a few seconds to several or many hours before the waxes, tars and gums are removed, either by centrifugation or filtration. The formation and precipitation of tars, gums and waxes is often time-dependent and complete precipitation may require holding the material at the low temperature employed until the process is complete. Thus, when conducting the process of this invention in a continuous fashion, the time elapsed between the chilling to precipitate waxes and actual separation of the waxes, tars and gums from the chilled coffee extract will depend on the exact nature of the extract.

In some coffee extracts, continued exposure to low temperature will also cause the formation of a non-waxy particulate precipitate. This particulate precipitate forms after the formation of insoluble tars, waxes and gums and does not interfere with the centrifugal separation of ice from concentrated coffee extract after the freeze concentration process. However, such exposure to low temperatures sufficient to cause this particulate precipitate should be avoided because it is tantamount to degradation of the coffee extract. The resulting concentrated product, after this degradation, is not as satisfactory to the consumer as coffee produced from extract which has been chilled only sufficiently to cause the precipitation of tars, gums and waxes.

Depending upon the exact nature of the coffee blend employed in preparing the extract and the extract itself, from less than 0.5 to about 5 percent by weight of tars, gums and waxes will form during the precipitation step. Although most of the gums, waxes and tars which will form from the coffee extract form at near the initial freezing point of the extract, more may form after the extract is subjected to freeze concentration. Thus, another embodiment of this invention comprises cooling the coffee extract to below the initial freezing temperature to precipitate the insoluble wax, tar or gum and forming a minor amount of ice in the extract. The extract can then be freed of the waxes and tars by filtration, decantation or centrifugation. In this embodiment of the invention, the minor portion of ice formed can be removed along with the waxes and tars, or the extract can be slightly warmed to allow the ice to melt prior to removal of the waxes and tars by filtration, decantation or centrifugation.

The tars, waxes or gums produced by the chilling of the coffee extract can be removed in any convenient fashion as pointed out above. The chilled extract may be held at the chilled temperature until such time as the precipitate settles to the bottom of the container and the precipitate-free portion of the solution can be decanted and then subjected to further processing. Alternatively, the chilled extract may be processed in the same manner as hot coffee extract which is to be freed from sediment. Thus, centrifugation, batch or continuous, or pressure filtration techniques; all well known to the art, may be employed to separate the extract from the precipitate.

After being freed from the precipitate, the resulting precipitate-free coffee extract is then subjected to concentration by partial freezing of the water therefrom. This freeze concentration process can be conducted in batch, semi-continuous or continuous apparatus according to methods known to the art and improvements of the methods. However, any method of removing the water from the coffee extract by crystallization as ice is applicable to the process of this invention. The resulting slurry of ice and concentrated coffee extract is then subjected to centrifugation to free the concentrated solution of the ice crystals. The resulting ice crystals are ordinarily washed with water or dilute coffee extract to free the ice crystals completely of residual mother liquor and the washings may be returned to the freeze concentration process. The practice of this invention has the advantage that the centrifuge basket does not become plugged with precipitated tars and waxes and the separation and washing processes are facilitated in their efficiency.

The freeze concentration of the wax, tar and gum free comestible liquid or extract can be accomplished in either a single stage or in a plurality of stages, each of which comprises a crystallizer in which heat is removed from the coffee extract to form a slurry of ice crystals and concentrated mother liquor. After each crystallization stage, ice is removed from the slurry and the concentrated extract either goes to further processing in the preparation of soluble or powdered coffee or is further concentrated in a subsequent stage of the freeze concentration process. The crystallization of ice from the extract is preferably carried out in a tubular heat exchanger, the outside surfaces of which are cooled by a circulating refrigerant. The internal section of the tube is ordinarily fitted with a shaft on which is located agitator paddles. Alternatively, a conventional scraped surface tubular heat exchanger may be employed. Any acceptable separating device or centrifuge may be employed for separating the concentrated coffee extract from the resulting ice crystals. This centrifuge is the preferred method for separating ice from the mother liquor and ordinarily consists of a rotating basket which contains perforations for allowing passage of the mother liquor. The centrifuge may also be equipped with some means for washing residual mother liquor from the ice crystals.

Referring now to the drawing accompanying this application, an aqueous comestible extract enters a chilling or cooling apparatus 10 through feed line 11. The chiller may be a conventional refrigeration unit, a continuous tubular heat exchanger or the chilling operation may be conducted in a batch manner by placing containers of extract in a refrigerated room. The chilled extract is then fed to the filter 12 through line 13. The filter apparatus may be a conventional batch filtration unit or, where the precipitated wax or tar can be handled on a centrifuge basket, may comprise a rotating basket centrifuge or ordinary laboratory or batch-type centrifuge. The filtered extract; now free of tars, gums and waxes; is conveyed through line 14 to the tubular crystallizer 15 where the temperature is lowered sufficiently to cause ice to form in the extract. The exact degree of concentration depends upon the cooling medium and temperature on the outside of the crystallizer 12 and the residence time in the crystallizer. Concentrated slurry of ice and mother liquor is then conducted to a separating apparatus 16 through the line 17. The separating apparatus 16 is preferably a rotating basket centrifuge in which the basket is an open screen material which allows concentrated mother liquor to be removed from the outside periphery of the centrifuge through the line 18 while ice, preferably reslurried in either water or feed extract, is removed via line 19.

As pointed out above, the crystallizing concentration operation may be conducted in a plurality of stages.

The following examples are illustrative of the process of this invention.

Example 1

A batch of coffee extract containing 24 percent coffee solids was pre-cooled to below 40° F. and admitted to a tubular heat exchanger having an internal agitator. The coffee extract was fed to the heat exchanger at the rate of 3 gallons per minute and coffee extract was recirculated around the heat exchanger until ice crystals had formed due to the cooling internally. Recirculation of slurry and mother liquor was continued as coffee extract was fed to the crystallizer, the internals of which were maintained at a temperature of 27° F. A slurry of ice and coffee liquor containing about 30 percent coffee solids was then continuously removed from the crystallizer and fed to a continuous type rotating basket centrifuge. The centrifuge basket was in the form of a perforated screen which allowed coffee liquor to pass through the ice cake, thus separating the ice from the coffee liquor. After 10 minutes of operation, the centrifuge screen plugged with tars and waxes which were precipitated from the coffee extract during the cooling and crystallization process. This caused the operation to stop, due to improper separation of ice and mother liquor.

This procedure is repeated except that the extract is fed to the crystallizer without first pre-chilling. Tars and gums form along with the ice and the centrifuge plugs in the same manner as if the extract had been pre-chilled.

Example 2

The general procedure of Example 1 was repeated except that the chilled coffee extract was filtered through fine cheesecloth prior to introduction into the crystallizer. In this filtration process, approximately 1.9 percent of the original extract was removed as tars, gums or waxes. The resulting precipitate-free coffee liquor was then admitted to the crystallizer vessel and the slurry produced in the crystallizer was centrifuged continuously. The ice-mother liquor separation was not impeded by plugging of the centrifuge screen with precipitate.

Excellent results are also obtained when coffee liquor to be concentrated is pre-cooled from 80 to 36° F., and when the extract has from 12 to 32 percent coffee solids.

Example 3

A tea extract containing 6.8 percent tea solids, at above 80° F. after extraction, is cooled in a heat exchanger to 36° F. The cooled material is then filtered through a filter press and the resulting tar-free extract is freeze concentrated in a tubular crystallizer. The resulting ice-concentrated tea slurry is easily separated on a rotating basket screen-type centrifuge as described above.

The process of this invention is applicable to any aqueous comestible liquid material or liquid extract which is to be concentrated by formation of ice and subsequent removal of ice. Thus, the process of this invention may be used in connection with the freeze concentration of coffee, tea, grape juice, orange juice, beer, vinegar and the like.

Although the invention has been described with reference to particular embodiments thereof, it is to be understood that various changes may be made without departing from the spirit of the invention as defined by the scope of the appended claims.

We claim:

1. In a process for the concentration of liquid coffee extract which forms insoluble precipitate at above the temperature at which ice forms therein and which contains therein about 10 to 40% dissolved solids comprising partial freezing of said liquid extract to form ice and concentrated liquid extract, the improvement which comprises precooling said liquid extract to a temperature between about 32 to 45° F. to precipitate insoluble material therefrom, storing said liquid extract in said temperature range until sufficient precipitate occurs without substantial adverse flavor effect, removing said insoluble material from said liquid extract, subsequently subjecting said liquid extract to reduced temperature to form ice therein, and separating ice from said concentrated extract.

2. The process of claim 1 wherein said coffee extract contains from 15 to 30 percent coffee solids.

3. The process according to claim 1 in which the liquid is kept under agitation during the precooling and precipitation to prevent adherence of wax and gum to the heat transfer surface.

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June 10, 1969 R. G. REIMUS ET AL 3,449,129
CONCENTRATION PROCESS
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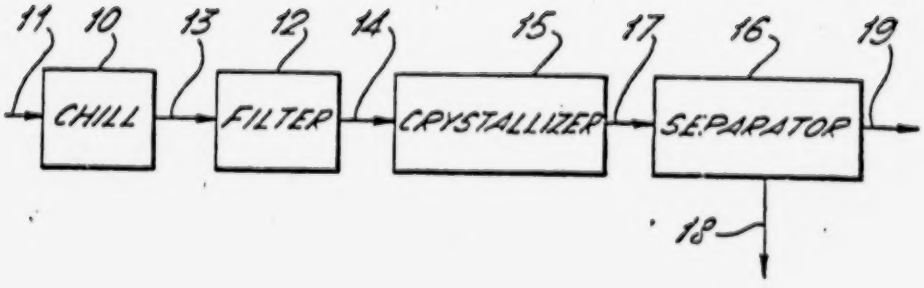

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CONCENTRATION PROCESS

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Application Apr. 3, 1968, Ser. No. 718,510, which is a division of application Ser. No. 511,173, Dec. 2, 1965, now Patent No. 3,381,302, dated Apr. 30, 1968. Divided and this application Sept. 27, 1968, Ser. No. 763,276

The portion of the term of the patent subsequent to Apr. 30, 1985, has been disclaimed

Int. Cl. A23f 1/08; B01d 1/00

U.S. Cl. 99—71 6 Claims

ABSTRACT OF THE DISCLOSURE

A process is described for the concentration of coffee liquid by partially freezing ice therein and separating the ice from the concentrated liquid. Prior to freezing the ice, the liquid is chilled to a temperature range from about 45° to 80° F. to form a mixture of waxes and similar material and liquid coffee extract and the mixture is treated so that waxes and similar material are removed from the liquid before the ice is formed.

This application is a division of our copending application Ser. No. 718,510 filed Apr. 3, 1968, which is a division of Ser. No. 511,173, now Patent No. 3,381,302.

This invention relates to an improvement in a process for the preparation of concentrated comestible liquids and liquid extracts and is particularly applicable to the preparation of soluble coffee solids or "powdered coffee." More particularly, this invention relates to the pre-treatment of liquids and liquid extracts as a step preliminary to removal of water from the extract by a freezing process.

Soluble, or "powdered," coffee has been prepared by first extracting coffee beans with hot water and subsequently dehydrating the extract by spray drying under vacuum conditions. This process has met with vast commercial success, but the flavor of the soluble coffee leaves much to be desired. The vacuum conditions employed not only remove water from the extract, but also cause volatile taste and flavor elements of the coffee to evaporate. The resulting soluble product is, therefore, never as good as the extract from which it is prepared.

To improve the flavor of the soluble coffee, it has been often proposed to remove substantial amounts of water in the extract by partially freezing the extract and separating the resulting pure ice crystals from the concentrated extract. This process of partial freezing is then followed by a complete dehydration by evaporation of water which may be conducted under vacuum conditions. In this way, the coffee loses less of the volatile components by virtue of the fact that the extract is subject to evaporation conditions for shorter periods of time.

In a preferred embodiment of the freezing process, the coffee extract is partially frozen by indirect refrigeration in a suitable crystallizer and the resulting slurry of ice and concentrate is subjected to centrifugation to separate the ice from the concentrate. In order for the process to be economical, this separation and the subsequent water wash of the crystals on the centrifuge basket must effect a relatively complete removal of mother liquor from the ice crystals.

However, when coffee extract is cooled to near its initial freezing point, a gummy or waxy solid material often precipitates from solution prior to ice formation. This wax or tar is carried along with the ice crystals and coffee extract into the centrifuge and collects on the centrifuge basket, eventually plugging the basket and preventing the complete separation of ice from concentrated extract.

This problem of the precipitation of insoluble materials in the coffee extract is not a problem exclusive to coffee extracts alone, but is also encountered in the preparation of other concentrated extracts of comestible materials. Thus, the process of this invention is also applicable to the preparation of concentrated extracts of such comestible materials as the tea, grape juice, apple juice, beer and orange juice.

It is therefore an object of this invention to provide an improved process for the concentration of comestible liquids and liquid extracts by partial freezing of the liquid or liquid extracts.

Another object of this invention is to provide a process in which a comestible liquid or liquid extract, free of insoluble elements at the freezing temperature of ice, is subjected to freeze concentration.

Yet another object of this invention is to provide an improved process for the concentration of coffee extract by partial freezing of the extract.

Still another object of this invention is to provide a process in which coffee extract, free of insoluble elements at the freezing temperature of ice, is subjected to freeze concentration.

The objects of this invention are accomplished by a process which comprises preparing a comestible liquid or liquid extract, cooling the liquid to precipitate material insoluble at the temperature at which ice forms therein, removing insolubles from the resulting mixture and then subjecting the insoluble-free mixture to concentration by partial freezing of water therefrom.

A preferred embodiment of this invention is a process which comprises extracting coffee beans at elevated temperatures with water to produce a coffee extract, cooling the extract to precipitate materials insoluble at the temperature at which ice forms in the brew, removing insolubles from the resulting mixture and then subjecting the insoluble free mixture to concentration by partial freezing of water therefrom.

The initial steps in the process of preparing instant coffee are the same as preparing regular coffee. Following roasting, the coffee is ground, but the granulation may be extremely coarse and, in some cases, fine particles that may result from grinding are sieved out and used elsewhere.

The grounds are placed in closed containers known as extractors. These extractors are set up in batteries with several extractors to a battery.

Ground coffee and hot water are charged into the first extractor. The coffee is then extracted until the necessary materials have been removed from the grounds. The resulting extract is then charged into the second extractor containing fresh coffee. The second extractor is run until extraction is completed. The resulting coffee extract (which is now stronger than ordinary coffee beverage) is placed in the third extractor containing fresh grounds and the brewing process is again repeated.

In commercial plant operation, the process is conducted in a semi-continuous manner, the fresh water coming into an extraction battery first reaches the extractor having the most spent, exhausted grounds and proceeds from there to the next most spent grounds and so on until, finally, in the last extractor it reaches the fresh, most recently added grounds. This is known as a coutnercurrent extraction system.

Temperature and pressure in the extractor system will vary greatly. Coffee being produced from fresh grounds is usually processed at low temperature with low pressure. Coffee being produced from spent, exhausted grounds is extracted at high temperature and under high pressure.

The coffee extract to be concentrated by freeze concentration can have any coffee solids content from a few percent to as high as 40 to 50 percent. That is, there may be as much as 40 to 50 lbs. of coffee solids in the extract for each 100 lbs. of extract. However, the lower the solids content of extract, the more the water which must be removed during the freeze concentration and drying steps. On the other hand, it has been found that carrying the extraction process to the point where high coffee solids content can be achieved often lowers the flavor quality of the extract. Thus, a preferred range of coffee solids content of the extract for the practice of this invention is from about 10 to 30 percent coffee solids.

In prior art processes, after leaving the extractor system, the coffee extract is clarified of sediment while still at an elevated temperature. One of the most common methods of clarification is by means of a centrifuge in which the coffee liquid is passed through a rapidly rotating cylinder and discharges the clear liquid. Another method is by means of a pressure pump forcing the concentrate through porous paper or cloth.

However, according to one embodiment of the process of this invention, the hot coffee extract is first chilled to near the freezing point so that waxes, tars and gums which are soluble in the hot extract are precipitated therefrom. The cold extract is then subjected to filtration or centrifugation to free it, not only of the precipitated gums, tars and waxes, but also from any sediment resulting from the extraction process.

Because the initial freezing point of the coffee extract is dependent on the total coffee solids content of the extract, the temperature to which the extract should be chilled to precipitate the gums, tars and waxes varies with the exact nature of the extract. Ordinarily, however minimum temperatures of 40° F. and below may be employed in the process of this invention. If it is not desired to form ice in the extract during the precipitation process, the temperature to which the extract is chilled should not be below the initial freezing point. For a coffee extract having 30 wt. percent coffee solids, the temperature is about 27° F.

In practice, it has been found that the tars, waxes and gums will begin to precipitate from coffee at temperatures as high as about 80° F. and that the major portion of insolubles will precipitate at temperatures above 32° F. Thus, an embodiment of this invention comprises chilling the extract to between 80 and 32° F. prior to filtration and freeze concentration. Preferred temperatures for the chilling operation are between about 45 and 32° F. because this temperature range insures virtually complete removal of insolubles.

The coffee extract may be chilled by any convenient means. However, it is preferred to keep the extract under agitation so that the wax and gums formed during the precipitation step do not adhere to the heat transfer surface of the refrigeration means used to precipitate. If desired, the chilled extract may be held at the low temperature for from a few seconds to several or many hours before the waxes, tars and gums are removed, either by centrifugation or filtration. The formation and precipitation of tars, gums and waxes is often time-dependent and

complete precipitation may require holding the material at the low temperature employed until the process is complete. Thus, when conducting the process of this invention in a continuous fashion, the time elapsed between the chilling to precipitate waxes and actual separation of the waxes, tars and gums from the chilled coffee extract will depend on the exact nature of the extract.

In some coffee extracts, continued exposure to low temperature will also cause the formation of a non-waxey particulate precipitate. This particulate precipitate forms after the formation of insoluble tars, waxes and gums and does not interfere with the centrifugal separation of ice from concentrated coffee extract after the freeze concentration process. However, such exposure to low temperatures sufficient to cause this particulate precipitate should be avoided because it is tantamount to degradation of the coffee extract. The resulting concentrated product, after this degradation, is not as satisfactory to the consumer as coffee produced from extract which has been chilled only sufficiently to cause the precipitation of tars, gums and waxes.

Depending upon the exact nature of the coffee blend employed in preparing the extract and the extract itself, from less than 0.5 to about 5 percent by weight of tars, gums and waxes will form during the precipitation step. Although most of the gums, waxes and tars which will form from the coffee extract form at near the initial freezing point of the extract, more may form after the extract is subjected to freeze concentration. Thus, another embodiment of this invention comprises cooling the coffee extract to below the initial freezing temperature to precipitate the insoluble wax, tar or gum and forming a minor amount of ice in the extract. The extract can then be freed of the waxes and tars by filtration, decantation or centrifugation. In this embodiment of the invention, the minor portion of ice formed can be removed along with the waxes and tars, or the extract can be slightly warmed to allow the ice to melt prior to removal of the waxes and tars by filtration, decantation or centrifugation.

The tars, waxes or gums produced by the chilling of the coffee extract can be removed in any convenient fashion as pointed out above. The chilled extract may be held at the chilled temperature until such time as the precipitate settles to the bottom of the container and the precipitate-free portion of the solution can be decanted and then subjected to further processing. Alternatively, the chilled extract may be processed in the same manner as hot coffee extract which is to be freed from sediment. Thus, centrifugation, batch or continuous, or pressure filtration techniques; all well known to the art, may be employed to separate the extract from the precipitate.

After being freed from the precipitate, the resulting precipitate-free coffee extract is then subjected to concentration by partial freezing of the water therefrom. This freeze concentration process can be conducted in batch, semi-continuous or continuous apparatus according to methods known to the art and improvements of the methods. However, any method of removing the water from the coffee extract by crystallization as ice is applicable to the process of this invention. The resulting slurry of ice and concentrated coffee extract is then subjected to centrifugation to free the concentrated solution of the ice crystals. The resuling ice crystals are ordinarily washed with water or dilute coffe extract to free the ice crystals completely of residual mother liquor and the washings may be returned to the freeze concentration process. The practice of this invention has the advantage that the centrifuge basket does not become plugged with precipitated tars and waxes and the separation and washing processes are facilitated in their efficiency.

The freeze concentration of the wax, tar and gum free consuible liquid or extract can be accomplished in either a single stage or in a plurality of stages, each of which comprises a crystallizer in which heat is removed from the coffee extract to form a slurry of ice crystals and

concentrated mother liquor. After each crystallization stage, ice is removed from the slurry and the concentrated extract either goes to further processing in the preparation of soluble or powdered coffee or is further concentrated in a subsequent stage of the freeze concentration process. The crystallization of ice from the extract is preferably carried out in a tubular heat exchanger, the outside surfaces of which are cooled by a circulating refrigerant. The internal section of the tube is ordinarily fitted with a shaft on which is located agitator paddles. Alternatively, a conventional scraped surface tubular heat exchanger may be employed. Any acceptable separating device or centrifuge may be employed for separating the concentrated coffee extract from the resulting ice crystals. This centrifuge is the preferred method for separating ice from the mother liquor and ordinarily consists of a rotating basket which contains perforations for allowing passage of the mother liquor. The centrifuge may also be equipped with some means for washing residual mother liquor from the ice crystals.

Referring now to the drawing accompanying this application, an aqueous comestible extract enters a chilling or cooling apparatus 10 through feed line 11. The chiller may be a conventional refrigeration unit, a continuous tubular heat exchanger or the chilling operation may be conducted in a batch manner by placing containers of extract in a refrigerated room. The chilled extract is then fed to the filter 12 through line 13. The filter apparatus may be a conventional batch filtration unit or, where the precipitated wax or tar can be handled on a centrifuge basket, may comprise a rotating basket centrifuge or ordinary laboratory or batch-type centrifuge. The filtered extract; now free of tars, gums and waxes; is conveyed through line 14 to the tubular crystallizer 15 where the temperature is lowered sufficiently to cause ice to form in the extract. The exact degree of concentration depends upon the cooling medium and temperature on the outside of the crystallizer 12 and the residence time in the crystallizer. Concentrated slurry of ice and mother liquor is then conducted to a separating apparatus 16 through the line 17. The separating apparatus 16 is preferably a rotating basket centrifuge in which the basket is an open screen material which allows concentrated mother liquor to be removed from the outside periphery of the centrifuge through the line 18 while ice, preferably resturried in either water or feed extract, is removed via line 19.

As pointed out above, the crystallizing concentration operation may be conducted in a plurality of stages.

The following examples are illustrative of the process of this invention.

EXAMPLE 1

A batch of coffee extract containing 24 percent coffee solids was pre-cooled to below 40° F. and admitted to a tubular heat exchanger having an internal agitator. The coffee extract was fed to the heat exchanger at the rate of 3 gallons per minute and coffee extract was recirculated around the heat exchanger until ice crystals had formed due to the cooling internally. Recirculation of slurry and mother liquor was continued as coffee extract was fed to the crystallizer, the internals of which were maintained at a temperature of 27° F. A slurry of ice and coffee liquor containing about 30 percent coffee solids was then continuously removed from the crystallizer and fed to a continuous type rotating basket centrifuge. The centrifuge basket was in the form of a perforated screen which allowed coffee liquor to pass through the ice cake, thus separating the ice from the coffee liquor. After 10 minutes of operation, the centrifuge screen plugged with tars and waxes which were precipitated from the coffee extract during the cooling and crystallization process. This caused the operation to stop, due to improper separation of ice and mother liquor.

This procedure is repeated except that the extract is fed to the crystallizer without first pre-chilling. Tars and gums form along with the ice and the centrifuge plugs in the same manner as if the extract had been pre-chilled.

EXAMPLE 2

The general procedure of Example 1 was repeated except that the chilled coffee extract was filtered through fine cheesecloth prior to introduction into the crystallizer. In this filtration process, approximately 1.9 percent of the orignal extract was removed as tars, gums or waxes. The resulting precipitate-free coffee liquor was then admitted to the crystallizer vessel and the slurry produced in the crystallizer was centrifuged continuously. The ice-mother liquor separation was not impeded by plugging of the centrifuge screen with precipitate.

Excellent results are also obtained when coffee liquor to be concentrated is pre-cooled from 80 to 36° F., and when the extract has from 12 to 32 percent coffee solids.

EXAMPLE 3

A tea extract containing 6.8 percent tea solids, at above 80° F. after extraction, is cooled in a heat exchanger to 36° F. The cooled material is then filtered through a filter press and the resulting tar-free extract is freeze concentrated in a tubular crystallizer. The resulting ice-concentrated tea slurry is easily separated on a rotating basket screen-type centrifuge as described above.

The process of this invention is applicable to an aqueous comestible liquid material or liquid extract which is to be concentrated by formation of ice and subsequent removal of ice. Thus, the process of this invention may be used in connection with the freeze concentration of coffee, tea, grape juice, orange juice, beer, vinegar and the like.

Although the invention has been described with reference to particular embodiment thereof, it is to be understood that various changes may be made without departing from the spirit of the invention as defined by the scope of the appended claims.

What is claimed is:

1. In a process for the concentration of liquid coffee extract, which forms insoluble precipitate material at above the temperature at which ice forms therein and which contains therein about 10 to 50% dissolved solids, comprising partial freezing of said liquid extract to form ice and concentrated liquid extract, the improvement which comprises: chilling said liquid extract to a temperature between about 45° and 80° F. to induce formation of insoluble precipitate material therein; holding said liquid extract in said temperature range until after insoluble precipitate material forms; removing said insoluble precipitate material from said liquid extract; subsequently subjecting said liquid extract to reduced temperature to form a mixture of ice and concentrated extract; and separating ice from said concentrated extract.

2. The process according to claim 1 in which the liquid extract is kept under agitation during holding and formation of precipitate.

3. The process according to claim 1 in which the coffee extract to be treated contains about 15% to 30% dissolved solids.

4. A process according to claim 1 in which ice is separated from coffee extract by centrifugation.

5. A process according to claim 1 in which insoluble precipitate is separated from coffee extract by centrifugation.

6. A process for preparing a dehydrated coffee beverage product soluble in water from a liquid coffee extract containing from about 10% to about 50% by weight dissolved solids, some of which form insoluble matter at a temperature above the temperature at which ice forms in the extract, including the steps of:

(a) chilling the extract to a temperature range of from about 80° F. to about 45° F. and maintaining the extract in the temperature range for a period of time

sufficient to precipitate at least a portion of the insoluble matter;

(b) removing the precipitated insoluble matter formed within the range of about 80° F. to about 45° F. from the extract; and

(c) then subjecting the extract to dehydration.

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U.S. Cl. X.R.

99—77, 199, 205

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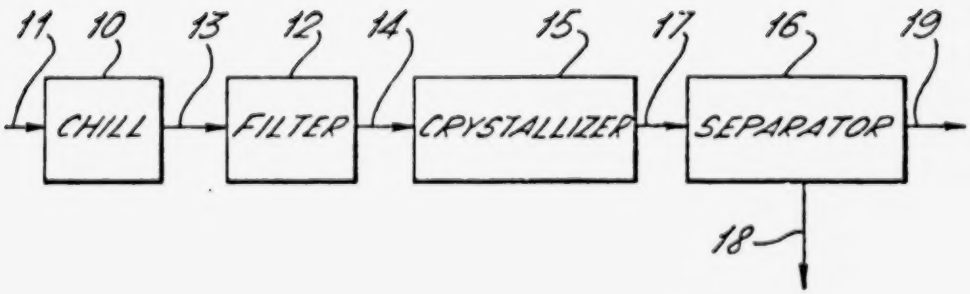

United States Patent

[11] 3,632,353

[72] Inventors Richard G. Reimus;
Anthony Saporito, both of Warren, Pa.

[21] Appl. No. 828,419
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[45] Patented Jan. 4, 1972

[73] Assignee Struthers Scientific and International Corporation

Continuation of Ser. No. 763,217, Sept. 27, 1968, abandoned, which is a division of application Ser. No. 718,510, Apr. 3, 1968, now Patent No. 3,432,308, dated Mar. 11, 1969, which is a division of application Ser. No. 511,173, Dec. 2, 1965, now Patent No. 3,381,302, dated Apr. 30, 1968. This application May 12, 1969, Ser. No. 828,419

[54] REMOVAL OF TARS AND WAXES IN FREEZE CONCENTRATION OF COFFEE

12 Claims, 1 Drawing Fig.

[52] U.S. Cl. 99/71, 99/71, 99/205, 99/199, 62/58
[51] Int. Cl. A23f 1/08, B01d 9/04
[50] Field of Search 99/71, 199, 205; 62/58

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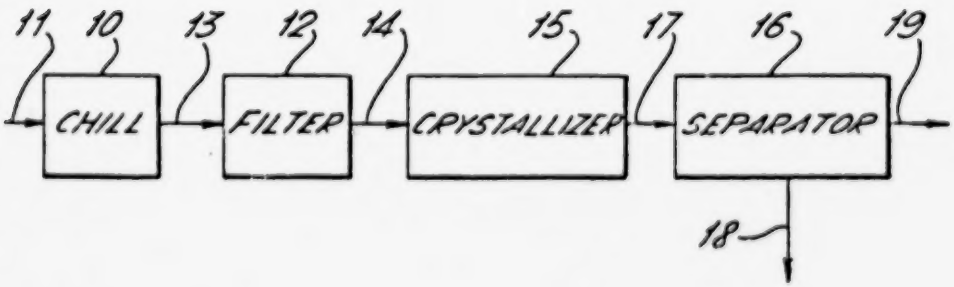
Primary Examiner—Norman Yudkoff
Assistant Examiner—R. T. Foster
Attorney—William A. Drucker

ABSTRACT: A process for making coffee concentrates is described in which liquid coffee of high solids concentration is chilled within a temperature range of 80° to 36° F. and precipitates formed within this temperature range are removed prior to freeze concentration by forming slush ice in the coffee, separating the ice from the coffee and then treating the ice so separated to recover residual coffee.



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1

REMOVAL OF TARS AND WAXES IN FREEZE CONCENTRATION OF COFFEE

This application is a continuation of Ser. No. 763,217 filed Sept. 27, 1968, now abandoned, which is a division of Ser. No. 718,510 filed Apr. 3, 1968, now US Pat. No. 3,432,308 issued Mar. 11, 1969, which in turn is a division of Ser. No. 511,173 filed Dec. 2, 1965, now U.S. Pat. No. 3,381,302 issued Apr. 30, 1968.

This invention relates to an improvement in a process for the preparation of concentrated comestible liquids and liquid extracts and is particularly applicable to the preparation of soluble coffee solids or "powdered coffee." More particularly, this invention relates to the pretreatment of liquids and liquid extracts as a step preliminary to removal of water from the extract by a freezing process.

Soluble, or "powdered," coffee has been prepared by first extracting coffee beans with hot water and subsequently dehydrating the extract by spray drying under vacuum conditions. This process has met with vast commercial success, but the flavor of the soluble coffee leaves much to be desired. The vacuum conditions employed not only remove water from the extract, but also cause volatile taste and flavor elements of the coffee to evaporate. The resulting soluble product is, therefore, never as good as the extract from which it is prepared.

To improve the flavor of the soluble coffee, it has been often proposed to remove substantial amounts of water in the extract by partially freezing the extract and separating the resulting pure ice crystals from the concentrated extract. This process of partial freezing is then followed by a complete dehydration by evaporation of water which may be conducted under vacuum conditions. In this way, the coffee loses less of the volatile components by virtue of the fact that the extract is subject to evaporation conditions for shorter periods of time.

In a preferred embodiment of the freezing process, the coffee extract is partially frozen by indirect refrigeration in a suitable crystallizer and the resulting slurry of ice and concentrate is subjected to centrifugation to separate the ice from the concentrate. In order for the process to be economical, this separation and the subsequent water wash of the crystals on the centrifuge basket must effect a relatively complete removal of mother liquor from the ice crystals.

However, when coffee extract is cooled to near its initial freezing point, a gummy or waxy solid material often precipitates from solution prior to ice formation. This wax or tar is carried along with the ice crystals and coffee extract into the centrifuge and collects on the centrifuge basket, eventually plugging the basket and preventing the complete separation of ice from concentrated extract.

This problem of the precipitation of insoluble materials in the coffee extract is not a problem exclusive to coffee extracts alone, but is also encountered in the preparation of other concentrated extracts of comestible materials. Thus, the process of this invention is also applicable to the preparation of concentrated extracts of such comestible materials as tea, grape juice, apple juice, beer and orange juice.

It is therefore an object of this invention to provide an improved process for the concentration of comestible liquids and liquid extracts by partial freezing of the liquid or liquid extracts.

Another object of this invention is to provide a process in which a comestible liquid or liquid extract, free of insoluble elements at the freezing temperature of ice, is subjected to freeze concentration.

Yet another object of this invention is to provide an improved process for the concentration of coffee extract by partial freezing of the extract.

Still another object of this invention is to provide a process in which coffee extract, free of insoluble elements at the freezing temperature of ice, is subjected to freeze concentration.

The objects of this invention are accomplished by a process which comprises preparing a comestible liquid or liquid extract, cooling the liquid to precipitate material insoluble at the temperature at which ice forms therein, removing insolubles from the resulting mixture and then subjecting the insoluble-free mixture to concentration by partial freezing of water therefrom.

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A preferred embodiment of this invention is a process which comprises extracting coffee beans at elevated temperatures with water to produce a coffee extract, cooling the extract to precipitate materials insoluble at the temperature at which ice forms in the brew, removing insolubles from the resulting mixture and then subjecting the insoluble-free mixture to concentration by partial freezing of water therefrom.

The initial steps in the process of preparing instant coffee are the same as preparing regular coffee. Following roasting, the coffee is ground, but the granulation may be extremely coarse and, in some cases, fine particles that may result from grinding are sieved out and used elsewhere.

The grounds are placed in closed containers known as extractors. These extractors are set up in batteries with several extractors to a battery.

Ground coffee and hot water are charged into the first extractor. The coffee is then extracted until the necessary materials have been removed from the grounds. The resulting extract is then charged into the second extractor containing fresh coffee. The second extractor is run until extraction is completed. The resulting coffee extract (which is now stronger than ordinary coffee beverage) is placed in the third extractor containing fresh grounds and the brewing process is again repeated.

In commercial plant operation, the process is conducted in a semicontinuous manner, the fresh water coming into an extraction battery first reaches the extractor having the most spent, exhausted grounds and proceeds from there to the next most spent grounds and so on until, finally, in the last extractor it reaches the fresh, most recently added grounds. This is known as a countercurrent extraction system.

Temperature and pressure in the extractor system will vary greatly. Coffee being produced from fresh grounds is usually processed at low temperature with low pressure. Coffee being produced from spent, exhausted grounds is extracted at high temperature and under high pressure.

The coffee extract to be concentrated by freeze concentration can have any coffee solids content from a few percent to as high as 40 to 50 percent. That is, there may be as much as 40 to 50 pounds of coffee solids in the extract for each 100 pounds of extract. However, the lower the solids content of the extract, the more the water which must be removed during the freeze concentration and drying steps. On the other hand, it has been found that carrying the extraction process to the point where high coffee solids content can be achieved often lowers the flavor quality of the extract. Thus, a preferred range of coffee solids content of the extract for the practice of this invention is from about 10 to 30 percent coffee solids.

In prior art processes, after leaving the extractor system, the coffee extract is clarified of sediment while still at an elevated temperature. One of the most common methods of clarification is by means of a centrifuge in which the coffee liquid is passed through a rapidly rotating cylinder and discharges the clear liquid. Another method is by means of a pressure pump forcing the concentrate through porous paper or cloth.

However, according to one embodiment of the process of this invention, the hot coffee extract is first chilled to near the freezing point so that waxes, tars and gums which are soluble in the hot extract are precipitated therefrom. The cold extract is then subjected to filtration or centrifugation to free it, not only of the precipitated gums, tars and waxes, but also from any sediment resulting from the extraction process.

Because the initial freezing point of the coffee extract is dependent on the total coffee solids content of the extract, the temperature to which the extract should be chilled to precipitate the gums, tars and waxes varies with the exact nature of the extract. Ordinarily, however, minimum temperatures of 40° F. and below may be employed in the process of this invention. If it is not desired to form ice in the extract during the precipitation process, the temperature to which the extract is chilled should not be below the initial freezing point.

For a coffee extract having 30 weight percent coffee solids, the temperature is about 27° F.

In practice, it has been found that the tars, waxes and gums will begin to precipitate from coffee at temperatures as high as about 80° F. and that the major portion of insolubles will precipitate at temperatures above 32° F. Thus, an embodiment of this invention comprises chilling the extract to between 80° and 32° F. prior to filtration and freeze concentration. Preferred temperatures for the chilling operation are between about 45° and 32° F. because this temperature range insures virtually complete removal of insolubles.

The coffee extract may be chilled by any convenient means. However, it is preferred to keep the extract under agitation so that the wax and gums formed during the precipitation step do not adhere to the heat transfer surface of the refrigeration means used to precipitate. If desired, the chilled extract may be held at the low temperature for from a few seconds to several or many hours before the waxes, tars and gums are removed, either by centrifugation or filtration. The formation and precipitation of tars, gums and waxes is often time-dependent and complete precipitation may require holding the material at the low temperature employed until the process is complete. Thus, when conducting the process of this invention in a continuous fashion, the time elapsed between the chilling to precipitate waxes and actual separation of the waxes, tars and gums from the chilled coffee extract will depend on the exact nature of the extract.

In some coffee extracts, continued exposure to low temperature will also cause the formation of a nonwaxey particulate precipitate. This particulate precipitate forms after the formation of insoluble tars, waxes and gums and does not interfere with the centrifugal separation of ice from concentrated coffee extract after the freeze concentration process. However, such exposure to low temperatures sufficient to cause this particulate precipitate should be avoided because it is tantamount to degradation of the coffee extract. The resulting concentrated product, after this degradation, is not as satisfactory to the consumer as coffee produced from extract which has been chilled only sufficiently to cause the precipitation of tars, gums and waxes.

Depending upon the exact nature of the coffee blend employed in preparing the extract and the extract itself, from less than 0.5 to about 5 percent by weight of tars, gums and waxes will form during the precipitation step. Although most of the gums, waxes and tars which will form from the coffee extract form at near the initial freezing point of the extract, more may form after the extract is subjected to freeze concentration. Thus, another embodiment of this invention comprises cooling the coffee extract to below the initial freezing temperature to precipitate the insoluble wax, tar or gum and forming a minor amount of ice in the extract. The extract can then be freed of the waxes and tars by filtration, decantation or centrifugation. In this embodiment of the invention, the minor portion of ice formed can be removed along with the waxes and tars, or the extract can be slightly warmed to allow the ice to melt prior to removal of the waxes and tars by filtration, decantation or centrifugation.

The tars, waxes or gums produced by the chilling of the coffee extract can be removed in any convenient fashion as pointed out above. The chilled extract may be held at the chilled temperature until such time as the precipitate settles to the bottom or the container and the precipitate-free portion of the solution can be decanted - - and then subjected to further processing. Alternatively, the chilled extract may be processed in the same manner as hot coffee extract which is to be freed from sediment. Thus, centrifugation, batch or continuous, or pressure filtration techniques; all well known to the art, may be employed to separate the extract from the precipitate.

After being freed from the precipitate, the resulting precipitate-free coffee extract is then subjected to concentration by partial freezing of the water therefrom. This freeze concentration process can be conducted in batch, semicontinuous or continuous apparatus according to methods known to the art and improvements of the methods. However, any method of removing the water from the coffee extract by crystallization as ice is applicable to the process of this invention. The resulting slurry of ice and concentrated coffee extract is then subjected to centrifugation to free the concentrated solution of the ice crystals. The resulting ice crystals are ordinarily washed with water or dilute coffee extract to free the ice crystals completely of residual mother liquor and the washings may be returned to the freeze concentration process. The practice of this invention has the advantage that the centrifuge basket does not become plugged with precipitated tars and waxes and the separation and washing processes are facilitated in their efficiency.

The freeze concentration of the wax, tar and gum free comestible liquid or extract can be accomplished in either a single stage or in a plurality of stages, each of which comprises a crystallizer in which heat is paddles. Alternatively, a conventional scraped surface tubular heat exchanger the coffee extract to form a slurry of ice crystals and concentrated mother liquor. After each crystallization stage, ice is removed from the slurry and the concentrated extract either goes to further processing in the preparation of soluble or powdered coffee or is further concentrated in a subsequent stage of the freeze concentration process. The crystallization of ice from the extract is preferably carried out in a tubular heat exchanger, the outside surfaces of which are cooled by a circulating refrigerant. The internal section of the tube is ordinarily fitted with a shaft on which is located agitator heat exchanger may be employed. Any acceptable separating device or centrifuge may be employed for separating the concentrated coffee extract from the resulting ice crystals. This centrifuge is the preferred method for separating ice from the mother liquor and ordinarily consists of a rotating basket which contains perforations for allowing passage of the mother liquor. The centrifuge may also be equipped with some means for washing residual mother liquor from the ice crystals.

Referring now to the drawing accompanying this application, an aqueous comestible extract enters a chilling or cooling apparatus 10 through feedline 11. The chiller may be a conventional refrigeration unit, a continuous tubular heat exchanger or the chilling operation may be conducted in a batch manner by placing containers of extract in a refrigerated room. The chilled extract is then fed to the filter 12 through line 13. The filter apparatus may be a conventional batch filtration unit or, where the precipitated wax or tar can be handled on a centrifuge basket, may comprise a rotating basket centrifuge or ordinary laboratory or batch-type centrifuge. The filtered extract; now free of tars, gums and waxes; is conveyed through line 14 to the tubular crystallizer 15 where the temperature is lowered sufficiently to cause ice to form in the extract. The exact degree of concentration depends upon the cooling medium and temperature on the outside of the crystallizer 12 and the residence time in the crystallizer. Concentrated slurry of ice and mother liquor is then conducted to a separating apparatus 16 through the line 17. The separating apparatus 16 is preferably a rotating basket centrifuge in which the basket is an open screen material which allows concentrated mother liquor to be removed from the outside periphery of the centrifuge through the line 18 while ice, preferably reslurried in either water or feed extract, is removed via line 19.

As pointed out above, the crystallizing concentration operation may be conducted in a plurality of stages.

The following examples are illustrative of the process of this invention.

EXAMPLE I

A batch of coffee extract containing 24 percent coffee solids were precooled to below 40° F. and admitted to a tubular heat exchanger having an internal agitator. The coffee extract was fed to the heat exchanger at the rate of 3 gallons per

minute and coffee extract was recirculated around the heat exchanger until ice crystals had formed due to the cooling internally. Recirculation of slurry and mother liquor was continued as coffee extract was fed to the crystallizer, the interials of which were maintained at a temperature of 27° F. A slurry of ice and coffee liquor containing about 30 percent coffee solids was then continuously removed from the crystallizer and fed to a continuous-type rotating basket centrifuge. The centrifuge basket was in the form of a perforated screen which allowed coffee liquor to pass through the ice cake, thus separating the ice from the coffee liquor. After 10 minutes of operation, the centrifuge screen plugged with tars and waxes which were precipitated from the coffee extract during the cooling and crystallization process. This caused the operation to stop, due to improper separation of ice and mother liquor.

This procedure is repeated except that the extract is fed to the crystallizer without first prechilling. Tars and gums form along with the ice and the centrifuge plugs in the same manner as if the extract had been prechilled.

EXAMPLE 2

The general procedure of example 1 was repeated except that the chilled coffee extract was filtered through fine cheesecloth prior to introduction into the crystallizer. In this filtration process, approximately 1.9 percent of the original extract was removed as tars, gums or waxes. The resulting precipitate-free coffee liquor was then admitted to the crystallizer vessel and the slurry produced in the crystallizer was centrifuged continuously. The ice mother liquor separation was not impeded by plugging of the centrifuge screen with precipitate.

Excellent results are also obtained when coffee liquor to be concentrated is precooled from 80° to 36° F., and when the extract has from 12 to 32 percent coffee solids.

EXAMPLE 3

A tea extract containing 6.8 percent tea solids, at above 80° F. after extraction, is cooled in a heat exchanger to 36° F. The cooled material is then filtered through a filter press and the resulting tar-free extract is freeze concentrated in a tubular crystallizer. The resulting ice-concentrated tea slurry is easily separated on a rotating basket screen-type centrifuge as described above.

The process of this invention is applicable to any aqueous comestible liquid material or liquid extract which is to be concentrated by formation of ice and subsequent removal of ice. Thus, the process of this invention may be used in connection with the freeze concentration of coffee, tea, grape juice, orange juice, beer, vinegar and the like.

Although the invention has been described with reference to particular embodiments thereof, it is to be understood that various changes may be made without departing from the spirit of the invention as defined by the scope of the appended claims.

We claim:

1. A process of the concentration of a liquid aqueous coffee extract which when chilled produces a precipitate which is insoluble in said extract above the temperature at which ice forms therein, comprising: chilling a feed liquid extract containing 24 percent by weight dissolved solids to a temperature between 80° and 36° F. to form a precipitate therein; holding said liquid extract at a chilled temperature below 80° F until precipitate forms; separating said precipitate and said extract; subsequently concentrating said extract by subjecting said liquid extract to reduced temperature to form a mixture of ice and concentrated liquid extract; separating ice from said concentrated extract; and treating the ice to recover residual coffee solids therefrom.

2. The process according to claim 1 in which the chilled extract is agitated at temperatures between 80° F. and 36° F.

3. A process according to claim 1 wherein the chilled extract is held at a temperature between 36° F. and 45° F.

4. A process according to claim 1 wherein the chilled extract after removal of precipitate is freeze concentrated to remove part of the water present in the extract, as ice, the ice is washed and coffee solids are recovered from the washings.

5. A process as claimed in claim 1 wherein separation of precipitate is effected by filtration above 36° F.

6. A process as claimed in claim 1 wherein separation of precipitate is effected by centrifugation above 36° F.

7. A process as claimed in claim 1 wherein the precipitate free liquid extract is concentrated in a single-stage crystallizing process.

8. A process as claimed in claim 1 wherein the precipitate free liquid extract is concentrated in a multistage crystallizing process.

9. A process as claimed in claim 1 wherein the precipitate free liquid extract is concentrated in a tubular scraped surface heat exchanger.

10. A process as claimed in claim 1 wherein ice is separated from the liquid in a centrifuge and the ice is washed while in the centrifuge.

11. A process as claimed in claim 10 wherein washing liquid is treated to recover coffee content therefrom after washing the ice.

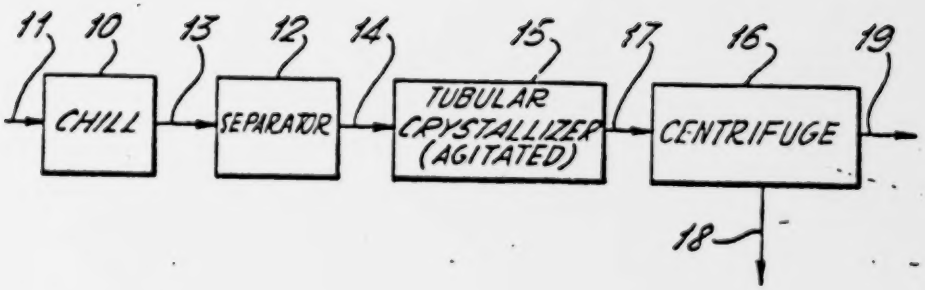
12. A process as claimed in claim 1 in which the extract is agitated while forming a mixture of ice and concentrated extract.

* * * * *

Oct. 28, 1969 R. G. REIMUS ET AL 3,474,723

BEVERAGE APPARATUS

Original Filed Dec. 2, 1965



United States Patent Office 3,474,723 Patented Oct. 28, 1969

3,474,723

BEVERAGE APPARATUS

Richard G. Reimus and Anthony Saporito, Warren, Pa., assignors to Struthers Scientific and International Corporation

Application Apr. 3, 1968, Ser. No. 718,510, now Patent No. 3,432,308, dated Mar. 11, 1969, which is a division of application Ser. No. 511,173, Dec. 2, 1965, now Patent No. 3,381,302, dated Apr. 30, 1968. Divided and this application Sept. 30, 1968, Ser. No. 763,851

Int. Cl. A23f 1/08; B01d 9/04

U.S. Cl. 99—236

5 Claims

ABSTRACT OF THE DISCLOSURE

A system of apparatus for removing water from coffee and tea extract by first chilling to form a suspension of solids in the liquid is provided which removes the solids from the liquid and thereafter forms a mixture of ice and liquid. The ice is separated in a centrifuge and is washed. Apparatus for removing the solids before forming ice prevents plugging of the centrifuge.

This application is a division of copending application Ser. No. 718,510, filed Apr. 3, 1968, now Patent No. 3,432,308 issued Mar. 11, 1969, which is a division of Ser. No. 511,173, now Patent No. 3,381,302 issued Apr. 30, 1968.

This invention relates to apparatus for the preparation of concentrated comestible liquids and liquid extracts and is particularly applicable to equipment for making soluble tea and coffee solids or "powdered coffee." More particularly, this invention relates to systems of equipment for use in the pretreatment of liquids and liquid extracts in a step preliminary to removal from the extract by a freezing process.

Soluble, or "powdered," coffee has been prepared by first extracting coffee beans with hot water and subsequently dehydrating the extract by spray drying under vacuum conditions. This process has met with vast commercial success, but the flavour of the soluble coffee leaves much to be desired. The vacuum conditions employed not only remove water from the extract, but also cause volatile taste and flavour elements of the coffee to evaporate. The resulting soluble product is, therefore, never as good as the extract from which it is prepared.

To improve the flavour of the soluble coffee, it has been often proposed to remove substantial amounts of water in the extract by partially freezing the extract and separating the resulting pure ice crystals from the concentrated extract. This process of partial freezing is then followed by a complete dehydration by evaporation of water which may be conducted under vacuum conditions. In this way, the coffee loses less of the volatile components by virtue of the fact that the extract is subject to evaporation conditions for shorter periods of time.

In a preferred embodiment of the freezing process, the coffee extract is partially frozen by indirect refrigeration in a suitable crystallizer and the resulting slurry of ice and concentrate is subjected to centrifugation to separate the ice from the concentrate. In order for the process to be economical, this separation and the subsequent water wash of the crystals on the centrifuge basket must effect a relatively complete removal of mother liquor from the ice crystals.

However, when coffee extract is cooled to near its initial freezing point, a gummy or waxy solid material often precipitates from solution prior to ice formation. This wax or tar is carried along with the ice crystals and coffee extract into the centrifuge and collects on the centrifuge

basket, eventually plugging the basket and preventing the complete separation of ice from concentrated extract.

This problem of the precipitation of insoluble materials in the coffee extract is not a problem exclusive to coffee extracts alone, but is also encountered in the preparation of other concentrated extracts of comestible materials. Thus, the apparatus of this invention is also applicable to the preparation of concentrated extracts of such comestible materials as tea, grape juice, apple juice, beer and orange juice.

According to this invention an apparatus for concentration of comestible liquids comprising a precooling device, a precipitate separation device, and a freeze concentration device are connected together in that order to form a system.

The initial steps in the process of preparing instant coffee are the same as preparing regular coffee. Following roasting, the coffee is ground, but the granulation may be extremely coarse and, in some cases, fine particles that may result from grinding are sieved out and used elsewhere.

The grounds are placed in closed containers known as extractors. These extractors are set up in batteries with several extractors to a battery.

Ground coffee and hot water are charged into the first extractor. The coffee is then extracted until the necessary materials have been removed from the grounds. The resulting extract is then charged in the second extractor containing fresh coffee. The second extractor is run until extraction is completed. The resulting coffee extract (which is now stronger than ordinary coffee beverage) is placed in the third extractor containing fresh grounds and the brewing process is again repeated.

In commercial plant operation, the process is conducted in a semi-continuous manner, the fresh water coming into an extraction battery first reaches the extractor having the most spent, exhausted grounds and proceeds from there to the next most spent grounds and so on until, finally, in the last extractor it reaches the fresh, most recently added grounds. This is known as a counter-current extraction system.

Temperature and pressure in the extractor system will vary greatly. Coffee being produced from fresh grounds is usually processed at low temperature with low pressure. Coffee being produced from spent, exhausted grounds is extracted at high temperature and under high pressure.

In prior art processes, after leaving the extractor system, the coffee extract is clarified of sediment while still at an elevated temperature. One of the most common methods of clarification is by means of a centrifuge in which the coffee liquid is passed through a rapidly rotating cylinder and discharges the clear liquid. Another method is by means of a pressure pump forcing the concentrate through porous paper or cloth.

However, according to one embodiment of this invention, the hot coffee extract is first chilled to near the freezing point so that waxes, tars, and gums which are soluble in the hot extract are precipitated therefrom. The cold extract is then subjected to filtration or centrifugation to free it, not only of the precipitated gums, tars and waxes, but also from any sediment resulting from the extraction process.

Because the initial freezing point of the coffee extract is dependent on the total coffee solids content of the extract, the temperature to which the extra should be chilled to precipitate the gums, tars and waxes varies with the exact nature of the extract. Ordinarily, however, temperatures of 80° F. to 40° F. may be employed in this invention. If it is not desired to form ice in the extract during the precipitation process, the temperature to which the extract is chilled should not be below the initial freezing point. For

a coffee extract having 30 wt. percent coffee solids, the temperature is about 27° F.

The coffee extract may be chilled by any convenient means. However, it is preferred to keep the extract under agitation so that the wax and gums formed during the precipitation step do not adhere to the heat transfer surface of the refrigeration means used to precipitate. If desired, the chilled extract may be held at the low temperature for from a few seconds to several or many hours before the waxes, tars and gums are removed, either by centrifugation or filtration. The formation and precipitation of tars, gums and waxes is often time-dependent and complete precipitation may require holding the material at the low temperature employed until the process is complete. Thus, when this invention in a continuous fashion, the time elapsed between the chilling to precipitate waxes and actual separation of the waxes, tars and gums from the chilled coffee extract will depend on the exact nature of the extract.

In some coffee extracts, continued exposure to low temperature will also cause the formation of a non-waxy particulate precipitate. This particulate precipitate forms after the formation of insoluble tars, waxes and gums and does not interfere with the centrifugal separation of ice from concentrated coffee extract after the freeze concentration process. However, such exposure to low temperatures sufficient to cause this particulate precipitate should be avoided because it is tantamount to degradation of the coffee extract. The resulting concentrated product, after this degradation, is not as satisfactory to the consumer as coffee produced from extract which has been chilled only sufficiently to cause the precipitation of tars, gums and waxes.

Depending upon the exact nature of the coffee blend employed in preparing the extract and the extract itself, from less than 0.5 to about 5 percent by weight of tars, gums and waxes will form during the precipitation step. Although most of the gums, waxes and tars which will form from the coffee extract form at near the initial freezing point of the extract, more may form after the extract is subjected to freeze concentration. Thus, the coffee extract may be cooled to below the initial freezing temperature to precipitate the insoluble wax, tar or gum and forming a minor amount of ice in the extract. The extract can then be freed of the waxes and tars by filtration, decantation or centrifugation. The minor portion of ice formed can be removed along with the waxes and tars, or the extract can be slightly warmed to allow the ice to melt prior to removal of the waxes and tars by filtration, decantation or centrifugation.

The tars, waxes or gums produced by the chilling of the coffee extract can be removed as pointed out above. The chilled extract may be held at the chilled temperature until such time as the precipitate settles to the bottom of the container and the precipitate-free portion of the solution can be decanted and then subjected to further processing. Alternatively, the chilled extract may be processed in the same manner as hot coffee extract which is to be freed from sediment. Thus, centrifugation, batch or continuous, or pressure filtration techniques; all well known to the art, may be employed to separate the extract from the precipitate.

After being freed from the precipitate, the resulting precipitate-free coffee extract is then subjected to concentration by partial freezing of the water therefrom. This freeze concentration process can be conducted in batch, semi-continuous or continuous apparatus according to methods known to the art and improvements of the methods. However, any method of removing the water from the coffee extract by crystallization as ice is applicable to the process of this invention. The resulting slurry of ice and concentrated coffee extract is then subjected to centrifugation to free the concentrated solution of the ice crystals. The resulting ice crystals are ordinarily washed with water or dilute coffee extract to free the ice crystals completely of residual mother liquor and the washings may be returned to the freeze concentration process. The practice of this invention has the advantage that the centrifuge basket does not become plugged with precipitated tars and waxes and the separation and washing processes are facilitated in their efficiency.

The freeze concentration of the wax, tar and gum free comestible liquid or extract can be accomplished in either a single stage or in a plurality of stages, each of which comprises a crystallizer in which heat is removed from the coffee extract to form a slurry of ice crystals and concentrated mother liquor. After each crystallization stage, ice is removed from the slurry and the concentrated extract either goes to further processing in the preparation of soluble of powdered coffee or is further concentrated in a subsequent stage of the freeze concentration process. The crystallization of ice from the extract is preferably carried out in a tubular heat exchanger, the outside surfaces of which are cooled by a circulating refrigerant. The internal section of the tube is ordinarily fitted with a shaft on which is located agitator paddles. Alternatively, a conventional scraped surface tubular heat exchanger may be employed. Any acceptable separating device or centrifuge may be employed for separating the concentrated coffee extract from the resulting ice crystals. This centrifuge is the preferred method for separating ice from the mother liquor and ordinarily consists of a rotating basket which contains perforations for allowing passage of the mother liquor. The centrifuge may also be equipped with means for washing residual mother liquor from the ice crystals.

Referring now to the drawing accompanying this application, an aqueous comestible extract enters a chilling or cooling apparatus 10 through feed line 11. The chiller may be a conventional refrigeration unit, a continuous tubular heat exchanger or the chilling operation may be conducted in a batch manner by placing containers of extract in a refrigerated room. The chilled extract is then fed to the separator filter 12 through line 13. The separator filter apparatus may be a conventional batch filtration unit or, where the precipitated wax or tar can be handled on a centrifuge basket, may comprise a rotating basket centrifuge or ordinary laboratory or batch-type centrifuge. The separated extract; now free of tars, gums and waxes; is conveyed through line 14 to the tubular crystallizer 15 where the temperature is lowered sufficiently to cause ice to form in the extract. The exact degree of concentration depends upon the cooling medium and temperature on the outside of the crystallizer 15 and the residence time in the crystallizer. Concentrated slurry of ice and mother liquor is then conducted to a centrifuge separating apparatus 16 through the line 17. The centrifuge separating apparatus 16 is preferably a rotating basket centrifuge in which the basket is an open screen material which allows concentrated mother liquor to be removed from the outside periphery of the centrifuge through the line 18 while ice, preferably reslurried in either water or feed extract, is removed via line 19.

As pointed out above, the crystallizing concentration operation may be conducted in a plurality of stages.

What we claim is:

1. An apparatus system for concentration of aqueous liquid coffee or tea extract comprising: precooling and holding means, a precipitate separation device, a first line conducting cooled extract from said precooling and holding means to said separation device, a tubular ice crystallizer, a second line conducting separated extract from said separation device to said tubular ice crystallizer, a centrifuge ice separator, a third line conducting a slurry of ice in a concentrated liquid extract to said centrifuge ice separator from said crystallizer, a fourth line conducting concentrated extract from said centrifuge ice separator, means removing ice from said centrifuge ice separator, and means for washing said ice.

2. An apparatus system according to claim 1 including means agitating said extract in said precooling and holding means.

3. An apparatus system according to claim 1 in which means are provided for washing said ice in said centrifuge.

4. An apparatus system according to claim 1 including means in said tubular ice crystallizer agitating said extract.

5. An apparatus system according to claim 1 in which said ice crystallizer is a scraped surface crystallizer.

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ROBERT W. JENKINS, Primary Examiner

U.S. Cl. X.R.

99—71, 77

United States Patent Office 3,404,007 Patented Oct. 1, 1968

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,404,007 October 1, 1968

John G. Muller

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 3, for "-50° C." read -- -45° C. --.

Signed and sealed this 4th day of February 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,404,007 October 1, 1968

John G. Muller

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 20, "250" should read -- .250 --; line 21, "200" should read -- .200 --; line 67, "250" should read -- .250 --.

Signed and sealed this 26th day of August 1969.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents

United States Patent Office

3,404,007
Patented Oct. 1, 1968

3,404,007

FREEZE DRIED COFFEE PROCESS AND PRODUCT

John G. Muller, Scarsdale, N.Y., assignor to Struthers Scientific and International Corporation, a corporation of Delaware

No Drawing. Filed Jan. 22, 1964, Ser. No. 323,574
5 Claims. (Cl. 99—71)

ABSTRACT OF THE DISCLOSURE

A process is provided for making concentrated coffee or tea in dry form by freeze concentration of an aqueous beverage extract in which solids are recovered from the ice crystals and the concentrated extract is freeze dried.

This invention relates to an improved process for the preparation of powdered soluble food products and is particularly applicable to the preparation of powdered or soluble coffee and tea.

Soluble or "powdered" coffee has been prepared by first extracting coffee beans with hot water and subsequently dehydrating the extract by spray drying under either vacuum, or slightly elevated pressure conditions. This process has met with vast commercial success, but the flavor of the soluble coffee leaves much to be desired. Volatile taste and flavor elements of the coffee are lost through evaporation, and more oxidation takes place also because of the elevated temperatures and pressure of air. The resulting soluble product is, therefore, never as good as the extract from which it is prepared.

To improve the flavor of the soluble coffee, it has been often proposed to remove substantial amounts of the water in the extract by partially freezing the extract and separating the resulting pure ice crystals from the concentrated extract. This process of partial freezing is then followed by a complete dehydration under vacuum conditions. In this way the coffee loses less of the volatile components by virtue of the fact that the extract is subject to vacuum conditions for shorter periods of time.

The conventional method for complete dehydration of the coffee product is by means of spraying the concentrated extract at high temperature into a tower to flash off all remaining water so that final product is a soluble powder. Unfortunately, during this flash evaporation process which is known as spray drying, much of the flavor components of the coffee which are volatile flash off along with the water and must somehow be replaced in the coffee powder. Even this replacement of the coffee aroma elements into the coffee powder produces a product which is not truly comparable to freshly brewed coffee.

Similarly, soluble powdered tea has been prepared by first brewing tea extract and then completely dehydrating the extract. As with powdered coffee, the soluble tea product leaves much to be desired in terms of its flavor.

It is therefore an object of this invention to provide an improved process for the preparation of soluble coffee and tea products. Another object of this invention is the preparation of powdered concentrate materials which may be reconstituted in water.

The objects of this invention are accomplished by a process for the preparation of a dehydrated beverage product, including soluble coffee and soluble tea, the process comprising preparing an extract of the beverage from a vegetable product containing extractable flavor, subjecting the extract to concentration by partial freezing to form ice crystals and a more concentrated extract, separating the more concentrated extract from the ice crystals and subjecting the more concentrated extract to relatively complete dehydration by freeze drying.

When applied to the preparation of soluble coffee, the process comprises preparing a coffee extract by extracting coffee grounds with water, subjecting the extract to concentration by partial freezing to form ice crystals and a concentrated coffee extract, separating the concentrated extract from the ice crystals and subjecting the concentrated extract to complete dehydration by freezing the concentrated extract to a solid mass and subjecting the thus frozen extract to dehydration under low temperatures and reduced pressure.

The initial steps in the process of preparing instant coffee are the same as preparing regular coffee. Following roasting, the coffee is ground, but the granulation may be extremely coarse, and, in some cases, fine particles that may result from grinding are sieved out and used elsewhere.

The grounds are placed in closed containers known as extractors. These extractors are set up in batteries with several extractors to a battery.

Ground coffee and hot water are charged into the first extractor. The coffee is then extracted until the necessary materials have been removed from the grounds. The resulting extract is then charged into the second extractor containing fresh coffee. The second extractor is run until extraction is completed. The resulting coffee extract (which is now stronger than ordinary coffee beverage) is placed in the third extractor containing fresh grounds and the brewing process is again repeated.

In commercial plant operation, the process is conducted in a semi-continuous manner, the fresh water coming into an extraction battery first reaches the exterior having the most spent, exhausted grounds and proceeds from there to the next most spent grounds and so on until, finally, in the last extractor it reaches the fresh, most recently added grounds. This is known as a countercurrent extraction system.

Temperature and pressure in the extractor system will vary greatly. Coffee being produced from fresh grounds is usually processed at low temperature with low pressure. Coffee being produced from spent, exhausted grounds is extracted at high temperature and under high pressure.

The coffee extract to be concentrated by freeze concentration can have any coffee solids content from a few percent (such as from about 3 to 10 percent) to as high as 40 to 50 percent. That is, there may be as much as 40 to 50 lbs. of coffee solids in the extract for each 100 lbs. of extract. However, the lower the solids content of the extract, the more the water which must be removed during the freeze concentration and drying steps. On the other hand, it has been found that carrying the extraction process to the point where high coffee solids content can be achieved often lowers the flavor quality of the extract. Thus, a preferred range of coffee solids content of the extract before freeze concentration for the practice of this invention is from about 10 to 30 percent coffee solids.

In prior art processes, after leaving the extractor system the coffee extract is clarified of sediment while still at an elevated temperature. One of the most common methods of clarification is by means of a centrifuge in which the coffee liquid is passed through a rapidly rotating cylinder and discharges the clear liquid. Another method is by means of a pressure pump forcing the concentrate through porous paper or cloth.

Various methods of preparing coffee extracts which may be employed in the process of this invention are described in Sivetz and Foote, "Coffee Processing Technology," volume 1, pages 261 through 319 and volume 2, pages 213 through 246, published by the AVI Publishing Company, Inc., Westport, Conn., in 1963. In addition, process and equipment described in the following U.S.

patents can be employed in preparing coffee extracts useful in the process of this invention: 2,340,758; 2,410,157; 2,515,730; 2,913,399; 2,915,403; 2,629,663; 2,783,149; 2,437,768.

After being freed from the sediment the resulting coffee extract is then subjected to concentration by partial freezing of the water therefrom. This freeze concentration process can be conducted in batch semi-continuous or continuous apparatus according to methods known to the art and improvements of the methods. However, any method of removing the water from the coffee extract by crystallization as ice is applicable to the process of this invention. The resulting slurry of ice and concentrated coffee extract is then subjected to centrifugation to free the concentrated solution of the ice crystals. The resulting ice crystals are ordinarily washed with water or dilute coffee extract to free the ice crystals completely of residual mother liquor and the washings may be returned to the freeze concentration process or to the extractors or to existing spray dryers.

The freeze concentration of the extract can be accomplished in either a single stage or in a plurality of stages each of which comprises a crystallizer in which heat is removed from the coffee extract to form a slurry of ice crystals and concentrated mother liquor. After each crystallization stage, ice is removed from the slurry and the concentrated extract either goes to further processing in the preparation of soluble or powdered coffee or is further concentrated in a subsequent stage of the freeze concentration process. The crystallization of ice from the extract is preferably carried out in a tubular heat exchanger, the outside surfaces of which are cooled by a circulating refrigerant. The internal section of the tube is ordinarily fitted with a shaft on which is located agitator paddles. Alternatively, a conventional scraped surface tubular heat exchanger may be employed. Any acceptable separating device or centrifuge may be employed for separating the concentrated coffee extract from the resulting ice crystals. This centrifuge is the preferred method for separating ice from the mother liquor and ordinarily consists of a rotating basket which contains perforations for allowing passage of the mother liquor. The centrifuge may also be equipped with some means for washing residual mother liquor from the ice crystals.

After concentration by partial freezing and separation of the resulting ice crystals, and prior to relatively complete dehydration by freeze drying, the concentrated coffee extract may contain from less than 30 to about 50 percent or more by weight of coffee solids. To reduce the water removal requirements of the freeze drying step, it is preferred that the effluent from the concentration by partial freezing contain as high as possible a percentage of coffee solids. However, the higher the percentage of coffee solids, the more viscous is the coffee liquor and the more difficult it is to separate efficiently from the ice crystals. Thus, a preferred embodiment of this invention comprises partially concentrated coffee extract having up to about 50 percent coffee solids prior to relatively complete dehydration by freeze drying.

Processes for concentration of the extract by a freezing process are described in vol. 2, pages 14 through 21 of Sivetz, Coffee Processing Technology, (The AVI Publishing Co., 1963). In addition, various processes for freeze concentration are described in the following U.S. patents: 2,977,234, 2,967,778, 2,888,353, 2,887,851, 2,862,824, 2,854,494, 2,851,368, 2,815,288, 2,800,001, 2,764,880, 2,764,488, 2,735,779, 2,734,355, 2,676,469, 2,657,551, 2,657,549, 2,559,204, 2,552,525, 2,552,523, 2,503,695.

After the coffee extract has been concentrated by partial freezing and separation of the resulting ice crystals, it is dehydrated to powder form by a method known in the art as freeze drying. According to this method, the coffee extract is frozen to a low temperature and subjected to vacuum conditions so that the ice sublimes away from the mass, leaving only the coffee solids containing but a small amount of water. During the vacuum sublimation of the ice, heat must be supplied to maintain the temperature at the particular level required to maintain the process at the vacuum conditions selected. Processes for freeze drying coffee extract are described in Van Arsdel, Food Dehydration, I, Principles, and Copely and Van Arsdel, Food Dehydration II, Products and Technology, both published by the AVI Publishing Company, Inc., Westport, Connecticut, 1963 and 1964 respectively. In addition, freeze drying processes and equipment are described in U.S. Patents: 2,620,573, 2,292,447, 3,132,929, 2,445,120, 1,979,124, 2,414,940, 2,302,253, 2,731,734, 2,994,132, 3,078,586, 3,132,930, 3,146,077, 3,178,829, 3,192,643, 3,199,217, 3,174,229, 2,353,986, 2,731,687, 2,411,192, 2,225,627, 2,374,232, 2,616,604, 2,930,139, 3,013,341, 3,088,222, 3,135,589, 3,176,408, 3,184,862, 3,192,645. To accomplish this freeze drying, the coffee solids are generally frozen to a temperature between —40° F. and —30° F. and subjected to pressures ranging from 250 mm. of Hg to 200 mm. of Hg. Depending upon the condition employed, residence times in the batch freeze drying apparatus vary from less than 4 to 10 hours, or longer. Where continuous freeze drying is employed, then residence time will be as long as 20 hours, or longer.

Coffee solids are generally dehydrated in this process to have between about 1 and 5 percent residual water. Therefore, as used throughout this specification, the term completely dehydrated coffee solids refers to the dehydrated coffee product prepared by freeze drying which contains from 1 to 5 percent moisture.

The soluble powdered coffee product prepared by the process of this invention has many advantages over the powdered material prepared by prior art processes. By following the process of this invention, the powdered coffee product has a flavor and aroma much more closely resembling that of freshly brewed coffee. This is because freeze concentration, combined with freeze drying, operates under such conditions whereby a minimum of the volatile coffee flavor and aroma elements are removed during processing. Furthermore, the soluble coffee product produced by the process of this invention may have a higher bulk density than soluble coffee products produced by prior art processes and, in addition, is more readily soluble in cold water than are prior art products and is darker in color.

EXAMPLE 1

Ground coffee and water are charged to a countercurrent extractor and extracted to result in an extract containing 24 percent soluble coffee solids. This extract was continuously metered into a crystallizer wherein 10 pounds per minute of water formed individual ice crystals to result in a slurry of concentrated coffee, having 32 percent soluble coffee solids and ice. This slurry was conveyed to a centrifuge having a basket rotating at 2200 revolutions per minute and a wash water rate of 4 pounds of fresh water per minute. The concentrated solution of coffee was discharged through the perforated rotating basket as product at the rate of 30 pounds per minute and contained 32 percent soluble coffee solids.

This solution is then poured onto trays and frozen at a temperature of —40° F. Then the trays are inserted into a freeze-drying apparatus. There, the ice in the frozen mass is sublimed as the pressure is reduced. The final pressure vacuum is 250 mm. Heating is applied to the shelfs on a programmed basis, with temperature ranging from 250°F. at the beginning of the cycle to 90°F. at its conclusion. Duration of the cycle is approximately 8 hours. The resulting dry coffee product has about three percent moisture and is readily soluble in water. It has a flavor preferable to soluble coffee prepared by other methods.

EXAMPLE 2

A tea extract containing 6.8 percent tea solids, at above 80°F. after extraction, is cooled in a heat exchanger to 36°F. The cooled material is then freeze concentrated in a tubular crystallizer. The resulting ice-concentrated tea slurry is then separated on a rotating basket screen-type centrifuge and frozen solid, then freeze dried to 3 percent moisture to give a superior soluble tea product.

Although the invention has been described with reference to particular embodiments thereof, it is to be understood that various changes may be made without departing from the spirit of the invention as defined by the scope of the appended claims.

I claim:

1. A process for the preparation of a dehydrated coffee beverage product which is readily soluble in cold water, said process comprising:

(a) preparing an aqueous coffee extract containing about 10 to 30 percent by weight of dissolved solids;

(b) subjecting said extract to concentration by partial freezing to form ice crystals and a more concentrated extract containing about 30 to about 50 percent by weight of solids;

(c) separating said more concentrated extract from said ice crystals by centrifugation; and

(d) subjecting said more concentrated extract to relatively complete dehydration by freezing the extract

to a solid mass and freeze drying to a moisture content of about 1 to 5 percent at temperatures between about 0° to −50° C.

2. The process according to claim 1 in which the ice is washed in step (c) and the washings are returned to step (b).

3. The process according to claim 1 in which the ice is washed in step (c) and the washings are returned to step (a).

4. The process according to claim 1 in which the ice is washed in step (c) and thereafter the washings are spray dried.

5. The product produced by the process of claim 1.

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MAURICE W. GREENSTEIN, *Primary Examiner.*

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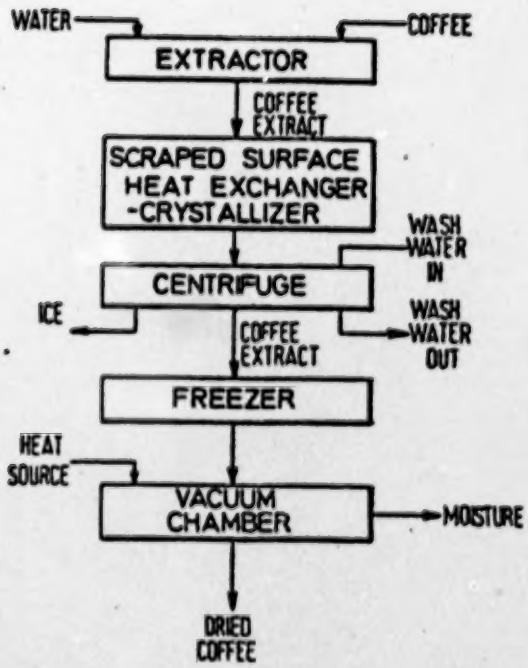
BEVERAGE APPARATUS

Original Filed Jan. 28, 1966



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BEVERAGE APPARATUS

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Application June 21, 1968, Ser. No. 738,776, which is a division of application Ser. No. 523,574, Jan. 28, 1966. Divided and this application June 2, 1969, Ser. No. 829,613

Int. Cl. A23f 1/08

U.S. Cl. 99—236 3 Claims

ABSTRACT OF THE DISCLOSURE

A system of apparatus for dehydrating coffee and tea is disclosed in which a freeze concentration device includes an integral agitator device and an ice separating centrifuge which is connected to a freeze drying device which removes moisture from the freeze concentrated product under vacuum by sublimation and heat.

The present application is a division of my copending application Ser. No. 738,776, filed June 21, 1968, which in turn is a division of Ser. No. 523,574, filed January 28, 1966, now U.S. Patent No. 3,404,007.

The drawing shows schematically the preferred connecting and arrangement of the system of apparatus according to the invention.

This invention relates to an improved process for the preparation of powdered soluble food products and is particularly applicable to the preparation of powdered or soluble coffee and tea.

Soluble or "powdered" coffee has been prepared by first extracting coffee beans with hot water and subsequently dehydrating the extract by spray drying under either vacuum or slightly elevated pressure conditions. This process has met with vast commercial success, but the flavor of the soluble coffee leaves much to be desired. Volatile taste and flavor elements of the coffee are lost through evaporation, and more oxidation takes place also because of the elevated temperatures and pressure of air. The resulting soluble product is, therefore, never as good as the extract from which it is prepared.

To improve the flavor of the soluble coffee, it has been often proposed to remove substantial amounts of the water in the extract by partially freezing the extract and separating the resulting pure ice crystals from the concentrated extract. This process of partial freezing is then followed by a complete dehydration under vacuum conditions. In this way the coffee loses less of the volatile components by virtue of the fact that the extract is subject to vacuum conditions for shorter periods of time.

The conventional method for complete dehydration of the coffee product is by means of spraying the concentrated extract at high temperature into a tower to flash off all remaining water so that the final product is a soluble powder. Unfortunately, during this flash evaporation process which is known as spray drying, much of the flavor components of the coffee which are volatile flash off along with the water and must somehow be replaced in the coffee powder. Even this replacement of the coffee aroma elements into the coffee powder produces a product which is not truly comparable to freshly brewed coffee.

Similarly, soluble powdered tea has been prepared by first brewing tea extract and then completely dehydrating the extract. As with powdered coffee, the soluble tea product leaves much to be desired in terms of its flavor.

It is therefore an object of this invention to provide an improved process for the preparation of soluble coffee and tea products. Another object of this invention is the

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preparation of powdered comestible materials which may be reconstituted in water.

The objects of this invention are accomplished by a process for the preparation of a dehydrated beverage product, including soluble coffee and soluble tea, the process comprising preparing an extract of the beverage from a vegetable product containing extractable flavor, subjecting the extract to concentration by partial freezing to form ice crystals and a more concentrated extract, separating the more concentrated extract from the ice crystals and subjecting the more concentrated extract to relatively complete dehydration by freeze drying.

When applied to the preparation of soluble coffee, the process comprises preparing a coffee extract by extracting coffee grounds with water, subjecting the extract to concentration by partial freezing to form ice crystals and a concentrated coffee extract, separating the concentrated extract from the ice crystals and subjecting the concentrated extract to complete dehydration by freezing the concentrated extract to a solid mass and subjecting the thus frozen extract to dehydration under low temperatures and reduced pressure.

The initial steps in the process of preparing instant coffee are the same as preparing regular coffee. Following roasting, the coffee is ground, but the granulation may be extremely coarse, and, in some cases, fine particles that may result from grinding are sieved out and used elsewhere.

The grounds are placed in closed containers known as extractors. These extractors are set up in batteries with several extractors to a battery.

Ground coffee and hot water are charged into the first extractor. The coffee is then extracted until the necessary materials have been removed from the grounds. The resulting extract is then charged into the second extractor containing fresh coffee. The second extractor is run until extraction is completed. The resulting coffee extract (which is now stronger than ordinary coffee beverage) is placed in the third extractor containing fresh grounds and the brewing process is again repeated.

In commercial plant operation, the process is conducted in a semi-continuous manner, the fresh water coming into an extraction battery first reaches the extractor having the most spent, exhausted grounds and proceeds from there to the next most spent grounds and so on until, finally, in the last extractor it reaches the fresh, most recently added grounds. This is known as a countercurrent extraction system.

Temperature and pressure in the extractor system will vary greatly. Coffee being produced from fresh grounds is usually processed at low temperature with low pressure. Coffee being produced from spent, exhausted grounds is extracted at high temperature and under high pressure.

The coffee extract to be concentrated by freeze concentration can have any coffee solids content from a few percent (such as from about 3 to 10 percent) to as high as 40 to 50 percent. That is, there may be as much as 40 to 50 lbs. of coffee solids in the extract for each 100 lbs. of extract. However, the lower the solids content of the extract, the more the water which must be removed during the freeze concentration and drying steps. On the other hand, it has been found that carrying the extraction process to the point where high coffee solids content can be achieved often lowers the flavor quality of the extract. Thus, a preferred range of coffee solids content of the extract before freeze concentration for the practice of this invention is from about 10 to 30 percent coffee solids.

In prior art processes, after leaving the extractor system the coffee extract is clarified of sediment while still at an elevated temperature. One of the most common methods of clarification is by means of a centrifuge in

which the coffee liquid is passed through a rapidly rotating cylinder and discharges the clear liquid. Another method is by means of a pressure pump forcing the concentrate through porous paper or cloth.

Various methods of preparing coffee extracts which may be employed in the process of this invention are described in Sivetz and Foote, "Coffee Processing Technology," vol. 1, pages 261 through 319 and vol. 2, pages 215 through 246, published by the AVI Publishing Company, Inc., Westport, Conn. in 1963. In addition, process and equipment described in the following U.S. patents can be employed in preparing coffee extracts useful in the process of this invention: 2,340,758; 2,410,157; 2,515,730; 2,915,399; 2,915,403; 2,929,663; 2,783,149; 2,437,768

After being freed from the sediment, the resulting coffee extract is then subjected to concentration by partial freezing of the water therefrom. This freeze concentration process can be conducted in batch, semi-continuous or continuous apparatus according to methods known to the art and improvements of the methods. However, any method of removing the water from the coffee extract by crystallization as ice is applicable to the process of this invention. The resulting slurry of ice and concentrated coffee extract is then subjected to centrifugation to free the concentrated solution of the ice crystals. The resulting ice crystals are ordinarily washed with water or dilute coffee extract to free the ice crystals completely of residual mother liquor and the washings may be returned to the freeze concentration process or to the extractors or to existing spray dryers.

The freeze concentration of the extract can be accomplished in either a single stage or in a plurality of stages each of which comprises a crystallizer in which heat is removed from the coffee extract to form a slurry of ice crystals and concentrated mother liquor. After each crystallization stage, ice is removed from the slurry and the concentrated extract either goes to further processing in the preparation of soluble or powdered coffee or is further concentrated in a subsequent stage of the freeze concentration process. The crystallization of ice from the extract is preferably carried out in a tubular heat exchanger, the outside surfaces of which are cooled by a circulating refrigerant. The internal section of the tube is ordinarily fitted with a shaft on which is located agitator paddles. Alternatively, a conventional scraped surface tubular heat exchanger may be employed. Any acceptable separating device or centrifuge may be employed for separating the concentrated coffee extract from the resulting ice crystals. This centrifuge is the preferred method for separating ice from the mother liquor and ordinarily consists of a rotating basket which contains perforations for allowing passage of the mother liquor. The centrifuge may also be equipped with some means for washing residual mother liquor from the ice crystals.

After concentration by partial freezing and separation of the resulting ice crystals, and prior to relatively complete dehydration by freeze drying, the concentrated coffee extract may contain from less than 30 to about 50 percent or more by weight of coffee solids. To reduce the water removal requirements of the freeze drying step, it is preferred that the effluent from the concentration by partial freezing contain as high as possible a percentage of coffee solids. However, the higher the percentage of coffee solids, the more viscous is the coffee liquor and the more difficult it is to separate efficiently from the ice crystals. Thus, a preferred embodiment of this invention comprises partially concentrated coffee extract having up to about 50 percent coffee solids prior to relatively complete dehydration by freeze drying.

Processes for concentration of the extract by a freezing process are described in vol. 2, pages 14 through 21 of Sivetz, Coffee Processing Technology (The AVI Publishing Co., 1963). In addition, various processes for freeze concentration are described in the following U.S. patents: 2,977,234; 2,967,778; 2,888,353; 2,887,851; 2,862,824; 2,854,494; 2,851,368; 2,815,288; 2,800,001; 2,764,880; 2,764,488; 2,735,779; 2,734,355; 2,676,469; 2,657,551; 2,657,549; 2,559,204; 2,552,525; 2,552,523; 2,503,695.

After the coffee extract has been concentrated by partial freezing and separation of the resulting ice crystals, it is dehydrated to powder form by a method known in the art as freeze drying. According to this method, the coffee extract is frozen to a low temperature and subjected to vacuum conditions so that the ice sublimes away from the mass, leaving only the coffee solids containing but a small amount of water. During the vacuum sublimation of the ice, heat must be supplied to maintain the temperature at the particular level required to maintain the process at the vacuum conditions selected. Processes for freeze drying coffee extract are described in Van Arsdel, Food Dehydration, I, Principles, and Copely and Van Arsdel, Food Dehydration II, Products and Technology, both published by the AVI Publishing Company, Inc., Westport, Conn., 1963 and 1964 respectively. In addition, freeze drying processes and equipment are described in U.S. patents: 2,620,573; 2,292,447; 3,132,929; 2,445,120; 1,979,124; 2,414,940; 2,302,253; 2,731,734; 2,994,132; 3,078,586; 3,132,930; 3,146,077; 3,178,829; 3,192,643; 3,199,217; 3,174,229; 2,353,986; 2,751,687; 2,411,152; 2,225,627; 2,374,232; 2,616,604; 2,903,139; 3,013,341; 3,088,222; 3,135,589; 3,176,408; 3,184,862; 3,192,645. To accomplish this freeze drying, the coffee solids are generally frozen to a temperature between —40° F. and —50° F., and subjected to pressures ranging from .250 mm. of Hg to .200 mm. of Hg. Depending upon the condition employed, residence times in the batch freeze drying apparatus vary from less than 4 to 10 hours, or longer. Where continuous freeze drying is employed, then residence time will be as long as 20 hours, or longer.

Coffee solids are generally dehydrated in this process to have between about 1 and 5 percent residual water. Therefore, as used throughout this specification, the term completely dehydrated coffee solids refers to the dehydrated coffee product prepared by freeze drying which contains from 1 to 5 percent moisture.

The soluble powdered coffee product prepared by the process of this invention has many advantages over the powdered material prepared by prior art processes. By following the process of this invention, the powdered coffee product has a flavor and aroma much more closely resembling that of freshly brewed coffee. This is because freeze concentration, combined with freeze drying, operates under such conditions whereby a minimum of the volatile coffee flavor and aroma elements are removed during processing. Furthermore, the soluble coffee product produced by the process of this invention may have a higher bulk density than soluble coffee products produced by prior art processes and, in addition, is more readily soluble in cold water than are prior art products and is darker in color.

EXAMPLE I

Ground coffee and water are charged to a countercurrent extractor and extracted to result in an extract containing 24 percent soluble coffee solids. This extract was continuously metered into a crystallizer wherein 10 pounds per minute of water formed individual ice crystals to result in a slurry of concentrated coffee, having 32 percent soluble coffee solids and ice. This slurry was conveyed to a centrifuge having a basket rotating at 2200 revolutions per minute and a wash water rate of 4 pounds of fresh water per minute. The concentrated solution of coffee was discharged through the perforated rotating basket as product at the rate of 30 pounds per minute and contained 32 percent soluble coffee solids.

This solution is then poured onto trays and frozen at a temperature of −40° F. Then the trays are inserted into a freeze-drying apparatus. There, the ice in the frozen mass is sublimed as the pressure is reduced. The final pressure vacuum is .250 mm. Heating is applied to the shelves on a programmed basis, with temperature ranging from 250° F. at the beginning of the cycle to 90° F. at its conclusion. Duration of the cycle is approximately 8 hours. The resulting dry coffee product has about three percent moisture and is readily soluble in water. It has a flavor preferably to soluble coffee prepared by other methods.

EXAMPLE 2

A tea extract containing 6.8 percent tea solids, at above 80° F. after extraction, is cooled in a heat exchanger to 36° F. The cooled material is then freeze concentrated in a tubular crystallizer. The resulting ice-concentrated tea slurry is then separated on a rotating basket screen-type centrifuge and frozen solid, then freeze dried to 3 percent moisture to give a superior soluble tea product.

Although the invention has been described with reference to particular embodiments thereof, it is to be understood that various changes may be made without departing from the spirit of the invention as defined by the scope of the appended claims.

What is claimed is:

1. A system of apparatus for preparing a dehydrated coffee or tea beverage product from an aqueous liquid, the extract, comprising:

(a) concentrating means for partially freezing the liquid extract to form ice therein by indirect exchange of heat across a tubular heat exchange surface between the extract and a circulating refrigerant;

(b) means coacting with concentrating means (a) for agitating extract and removing ice from said tubular heat exchange surface;

(c) centrifuge means for separating ice formed in the extract from said liquid extract;

(d) freezing means for freezing the extract;

(e) means for removing moisture under vacuum from frozen extract by sublimation; and

(f) heat source means coacting with vacuum means for heating and drying the frozen extract.

2. The apparatus of claim 1 including means coacting with the centrifuge means (c) for washing ice separated from the extract.

3. The apparatus of claim 2 including means coacting with the centrifuge means (c) for recovering solids from washings.

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ROBERT W. JENKINS, Primary Examiner

U.S. Cl. X.R.

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